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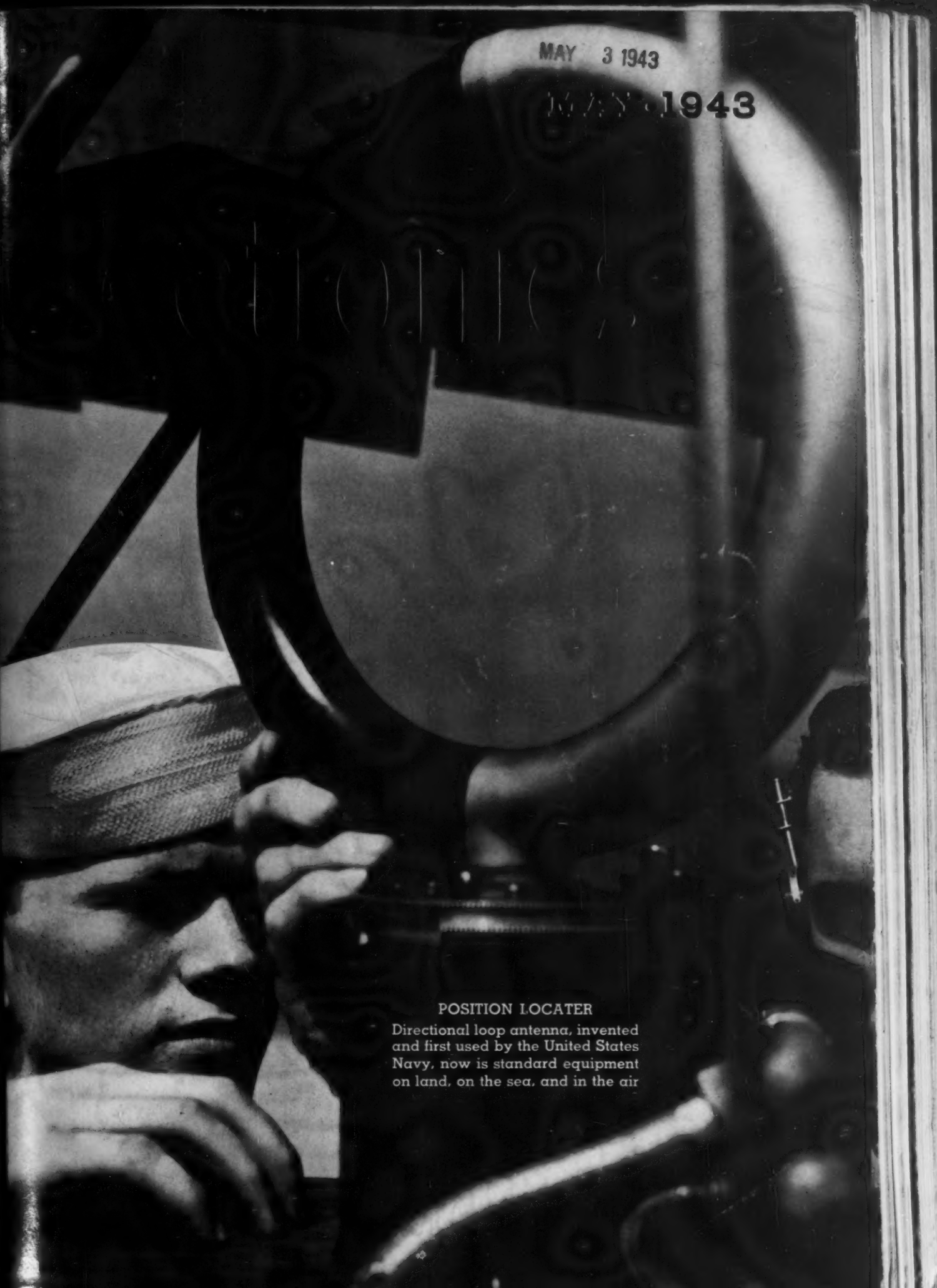

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Designs for War . . . Transformers

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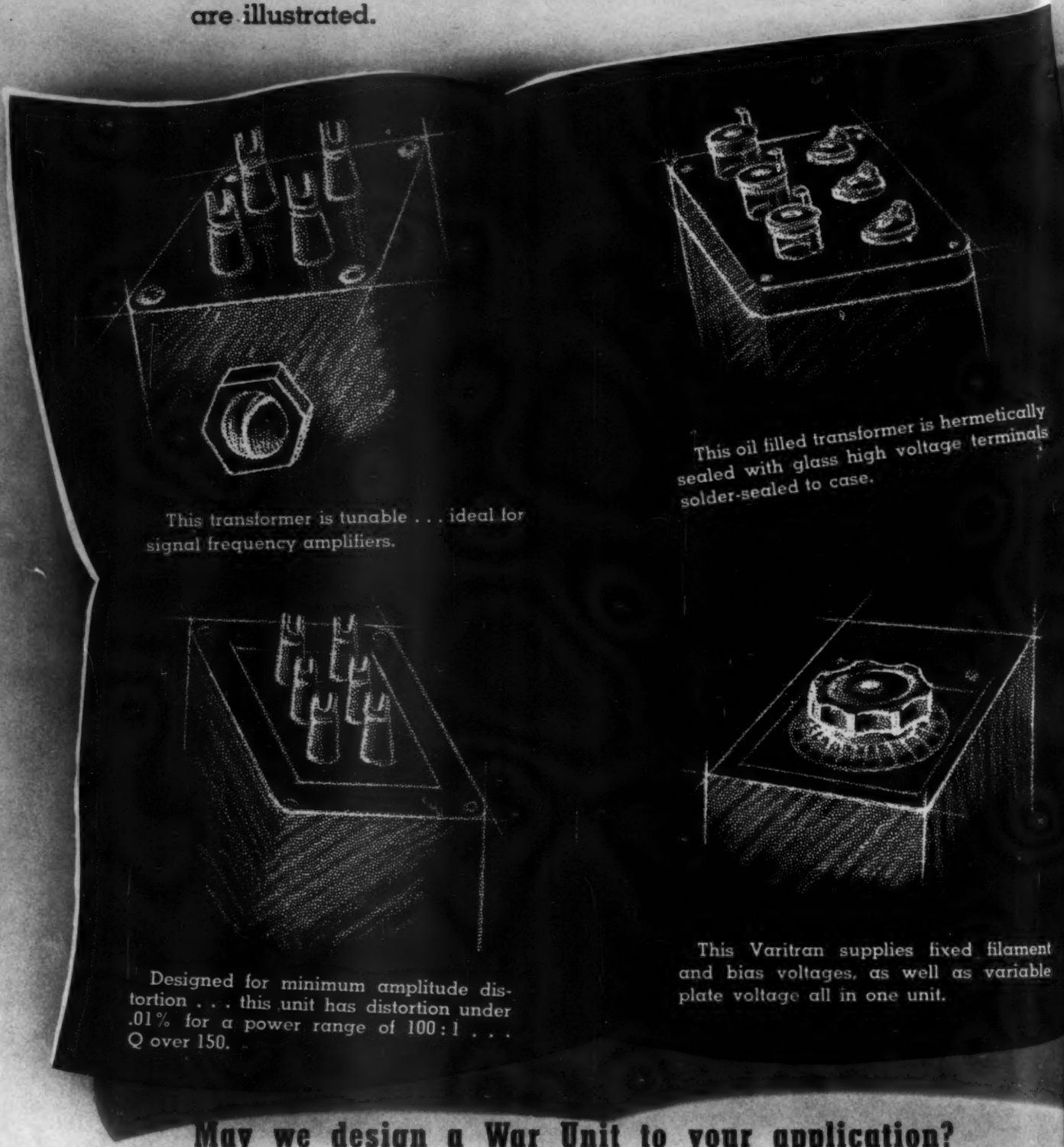

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electronics

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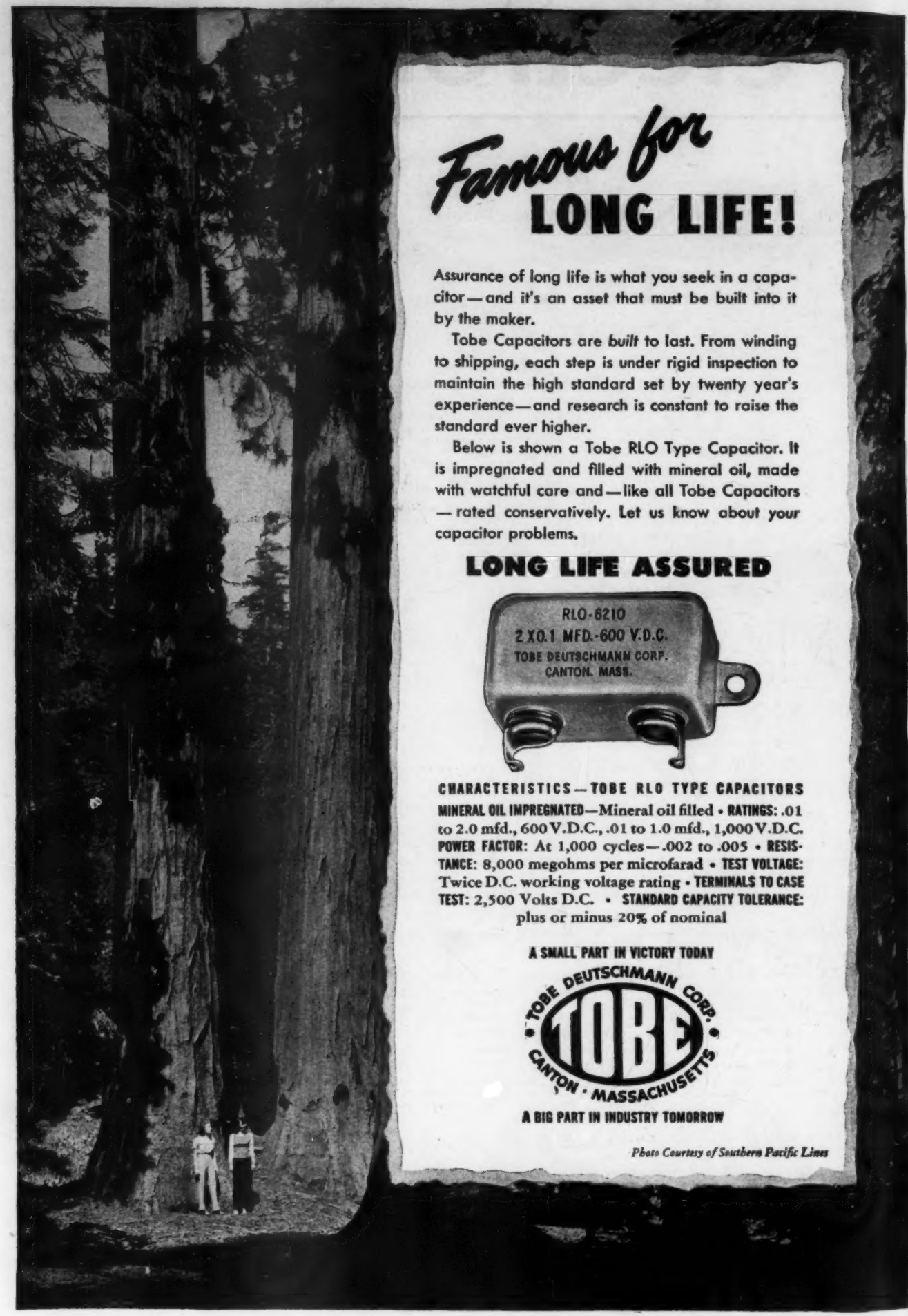

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A BIG PART IN INDUSTRY TOMORROW

Photo Courtesy of Southern Pacific Lines

WASHINGTON FEEDBACK

Attention of government and radio manufacturers is currently centered on two problems. First is the setting up of a program for production of sufficient replacement tubes to maintain radio reception in the home, urban and rural. Second is the fear of some manufacturers that they may be overtaken by a slump in military orders because of a lag between manufacture of radio apparatus and the equipment in which such apparatus is installed. There is every reason to believe that the problem of radio for the home is on the way to a solution and there is equal reason to believe that the concern of manufacturers as to future government orders can be discounted for the present at least.

WPB—Seven manufacturers have put into production the revised list of radio replacement tubes for civilian use. A highly placed official of WPB states that all of these manufacturers have been allocated substantial quantities of material for the civilian tube program. He flatly denies that manufacturers have been handicapped on account of materials. He cites the sale of almost 2,500,000 replacement tubes by manufacturers in January, which he contends would not have been possible if critical materials had been withheld.

In further support of this contention, Frank H. McIntosh, Assistant Director of the Radio Division of WPB, made the statement that a careful survey of the industry indicated that radio tube production for replacement purposes is almost as high as in normal times. "Maldistribution" he said, "caused by the inability of manufacturers to round out their lines and low production of certain types of tubes appears to be responsible in part for the present shortage." McIntosh urges manufacturers to concentrate civilian production on critical tube types, even though they may be low in profit, and to exchange tubes among themselves to make up the sets.

A tube-for-tube order at retail level is now in the works at WPB. The old tube would act as a ration coupon. In all probability certificates would be issued to show that the old tube was collected when the new one was taken. The effect of the order as contemplated would make it unbusinesslike to hoard tubes since they would be virtually frozen.

The current farm radio battery shortage is receiving the attention of the Consumers Durable Goods Division of WPB which promises some relief through readjustment and rescheduling of battery production, depending on temporary let-up in other battery requirements. It is estimated that battery-operated radios on farms have increased in numbers from a pre-war 2,200,000 to a present total of 3,200,000. Pre-war production of radio batteries approximated 4,500,000 sets of batteries, sufficient to supply about two sets of batteries per year per radio. Even return to production on a pre-war scale—utterly impossible at present—would not meet this year's battery demand on the basis of two-battery-sets-per-radio annually. As one step to improve the situation, which is serious, Order L-71 has prohibited the production of batteries for portable radios.

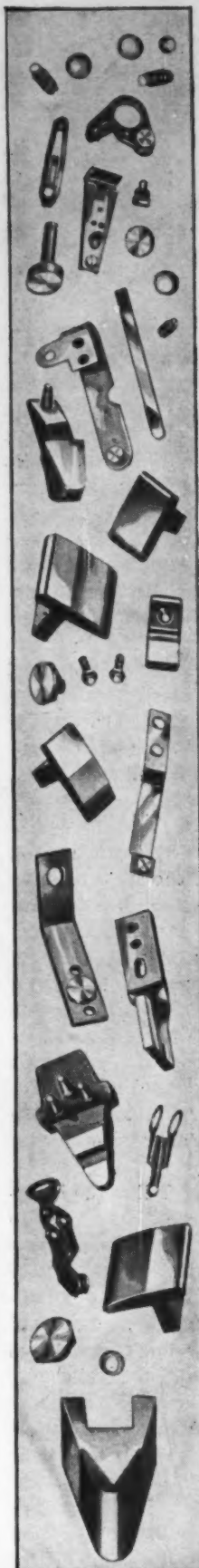
In dismissing the concern of manufacturers as to the amount of future orders for the military, WPB takes the position that whatever lag there has been is purely temporary, largely due to faulty scheduling and delays in placing orders. Producers are urged to run off their backlogs as rapidly as possible with every assurance from WPB that military orders will come in reasonably soon.

If the case of Western Electric is typical, there is little in the picture to indicate that a shut-down or partial shut-down is imminent. This company's recent report shows direct and indirect sales of $290,934,000 to the government in 1942 with the proportion of sales to government rising steadily and accounting for 82 percent of the total in December. However, the end of the year found $936,142,000 of unfilled government orders on the company's books.

FCC—Post-war development of an all-purpose receiver capable of handling FM, color television and facsimile is anticipated by Commissioner Fly. With such a receiver, a person would listen for a while to FM broadcasts, switch to television at appropriate hours, and from time to time tear off the news reports. "I look for one very thorough-going and efficient form of broadcasting", says Chairman Fly. "It will be a chain operation carried by radio relay—these relay problems are pretty well licked now. It would naturally be chain operation because of the difficulties and high costs involved in programming television in the various smaller stations. This business of having television broadcasting, standard broadcasting, FM, facsimile, and separate receivers and separate services—that represents the horse-and buggy days of radio and will be all washed out."

ERSA—Laboratories working on radio problems for the army or navy will be able to get from a central source of supply the critical electronic components not quickly available in commercial channels through the Electronic Research Supply Agency formed by the Defense Supplies Corp., at the request of the Armed services, the OSRD, and WPB to supply research men with the electronic components vital to their work.

This new Agency will make it unnecessary for the laboratories to build up their own complete stockpiles of components. WPB officials pointed out that laboratory stockpiles often are made up of components which do not meet standards preferred by the army and navy. The agency will be able to direct laboratory purchases to the preferred types. Operating without profit, the agency is managed by an executive committee on which the army, the navy, and other government agencies are represented. Its offices and stockrooms will be located in New York City. Laboratories will, of course, not be compelled to place their purchase orders with or through ERSA—G.T.M.



Not All Bug Hunters Are Biologists

A good many of them are engineers—and the bugs they hunt are performance flaws in vital production. Mallory contact engineers have been making some nice records in quickly "getting the bugs" out of tricky contact problems.

There was, for example, the case of an unusually designed aircraft relay, used in propeller control mechanism. The relay used contacts which butted together, rotating against each other during operation. Ordinary facing materials ground off fine particles which shortly formed an insulating layer to make the contacts inoperative.

It was up to Mallory to find an answer . . . and quickly. Actual conditions of operation were set up; one material after another tested, new alloys originated. Mallory experience and "know how" speeded the solution to a prompt conclusion with a complete contact assembly. A new material was developed, a suitable backing evolved and shortly the contact relays functioned perfectly. Another cog in War Production mechanism was in good working order. It sounds very simple and matter of fact.

But what made the result seem so simple was the applied technique of many years of research and experiment. Mallory engineers have pioneered so long in the contact field that their knowledge brings prompt results as a matter of course.

While the design is still in blueprint form

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CROSS TALK

▸**PATENTS** . . . The fact that Thurman Arnold is now a judge in the U. S. Circuit Court of Appeals and no longer head of the Justice Department's Anti-trust Division should not lull to sleep those whose fears of patent office reform were so prevalent not long ago. Bills to revamp the patent system are always before Congress. They make good platforms for those who wish to air their views.

Judge Arnold appeared recently before the subcommittee on technological mobilization of the Senate Military Affairs Committee. He charged, once again, that domestic and international cartels controlled research and invention, causing wartime shortages in a number of critical materials. He reiterated what he has so often said, namely that the only way to free the nation's economy is to "break up the patent pools". He endorsed the bill sponsored by Senator Harley M. Kilgore (D. West Va.) for the establishment of an office of technological mobilization, stating that this bill is designed to break the corner on research and experimentation now enjoyed by private groups.

While saying that he did not want to discourage private research, Judge Arnold added, "Only the government can provide opportunity for the inventors and technicians who do not choose to work exclusively for the benefit of a private group necessarily trying to get control of the market if it can." The bill would give the government authority and funds to promote such research. When asked by Senator Kilgore, chairman of this sub-committee, for suggestions for the bill, he replied that it should be so drafted that "blitzkrieg" nuisance suits would not be permitted against inventors.

Furthermore, the virtual abolition of the National Resources Planning Board by Congressional refusal of funds attracted more attention than the proposals of the Board. Thus many people have probably overlooked the fact that revamping of the patent laws with compulsory licensing and also a hint for condemnation acquisition of suppressed patents by the government were among the hundreds of suggestions for post-war planning on a gigantic scale set forth by this body.

A great deal of attention, however, will be given to the findings of the National Patent Planning Commission whose report is almost completed and will probably be sent to President Roosevelt within a month. The Commission is made up of Charles Kettering, chairman, Commisioner Conway P. Coe, Executive Secretary, Owen D. Young, Francis Gaines, Chester Davis (now Food Administrator) and Edward Grady.

Present thinking in Washington indicates that any extensive overhauling of the patent system will not take place this year.

▸**ESSENTIAL SOUND** . . . Certain difficulties between one large maker of inter-communicating equipment and a government agency recently resulted in shutdown of the plant for an indefinite period. There may or may not have been justification for this drastic action but there appeared to be none for shutting down another factory in the same field for a week as a precautionary measure while the first case was under examination. Nor is there now any reason for eyeing the activities of all manufacturers in the sound business with thinly veiled suspicion just because one of their number allegedly did some finagling.

Rapid, step-saving communications between departments, bolstering of worker morale and the protection against sabotage inherent in many installations represent truly essential functions of inter-communicating apparatus in industrial plants —not to mention the essential sound applications to the military. What is needed is more sound equipment; not less.

▸**DISEASE** . . . There may be nothing but coincidence in this, but it looks like a sign of occupational disease to us. Sound-effects man giving a talk before Radio Club of America audience on many phases of his job, wound up his talk within 15 seconds of the hour allotted to him, without ever looking at a time piece.

POST-WAR

Future development of the commercial market must be a secondary concern today but a little thinking about tomorrow in whatever time the military production program affords is good business. Reported here are some of the things manufacturers are discussing

NO ONE KNOWS when the war will end and few have the temerity to bet that it will be soon. Homefront minds and muscles are therefore concentrated upon the problem of winning it, almost but not quite to the exclusion of everything else. Congress itself is beginning to think about post-war planning and so also is industry. Men have learned to keep an eye on the future no matter what the exigencies of the moment and not even an all-out fight can completely break the habit.

Government-sponsored groups such as the Department of Commerce Committee for Economic Development and the National Resources Planning Board, general industry organizations like the National Planning Association and bodies such as the Radio Manufacturers Association and the Sales Managers Club, within the electronics field itself, are concerning themselves with broad economic questions. These include maintenance of full employment, utilization of expanded plant capacity and the relationship between Washington and industry after the war ends.

Individual manufacturers, leaving such questions to organized government and industry groups, are nevertheless thinking about more specific post-war planning problems and some of their current thoughts are worth reporting.

Design Manpower

Business available immediately after the war depends to a considerable extent upon what product improvements and new devices the industry has ready for sale. Development of equipment with which to initially whet the consumer appetite hinges heavily upon the availability of engineering manpower right now —and it is common knowledge that technical personnel in electronic equipment plants is just about down to bed-rock. Even where design specialists have not yet been lost to the services, almost without exception it has been necessary to shift them to production.

There are, it appears, two major reasons for this wholesale changeover. The first, obviously, is continued pressure from the Army and Navy for more equipment urgently needed on the fighting fronts. The second, not quite so apparent, is the transfer of remaining engineers by manufacturers who are becoming increasingly aware of the fact that Draft Boards exhibit little patience with requests for deferment unless men are directly employed in the production of military gear. It has occasionally even been considered desirable to switch to production those engaged in military equipment development, the adjective "production" apparently cutting more ice when appearing in close juxtaposition to the noun "engineer" than does the word "design."

Fortunate indeed are those manufacturers who had improved models, or completely new products, ready or nearly ready for introduction when the outbreak of hostilities pinched off the commercial market. By taking such things off the shelf and giving them the little attention needed to polish them up, these plants can be ready to go shortly after the Axis throws in the towel. Even a casual survey reveals, however, that factories in this delightful position are not numerous.

Government funds are still financing research that might otherwise have dawdled for years and are simultaneously providing manufacturing facilities at a far faster rate than would have been possible in peacetime. So, in spite of the shortage of engineering manpower, there will undoubtedly be improved electronic products and a few brand-new devices emanating directly from wartime research on the market soon after the last shot is fired. These, plus hold-overs from the pre-war period, assure the industry of a post-war head start. It is unlikely, however, that anything like peak development of the market will occur until the more distant future.

Product Development

Conservative manufacturers are already pointing out the following factors: Many of the bright new uses for tubes in military gear may have no immediate practical commercial application. Some of those that do look useful may be kept under War Department wraps long after the shindig ends. Releasable ideas which have peacetime volume possibilities may take considerable time to modify for commercial use. In any case, whether post-war new product designs are controlled by Washington or by the industry itself, quite a few calendar pages may be flipped over before factories can whip these ideas into salable form, obtain materials necessary for their construction, convert plant machinery for their production and, finally, arrange suitable channels of distribution. Therefore, many think it unwise and unnecessary to promise the consumer too much, too soon. The future of electronics, they say, is sufficiently impressive without "whoopla."

PLANNING PROBLEMS

Manufacturers of equipment destined for use by the general public are becoming aware of the possibility that the promise of radically different merchandise, along with the implication that it will be available immediately after the war, could be very easily overdone. There will be important extensions of audio and video entertainment services and some purely utilitarian applications of tubes but most of these will not be completely new to people whose memories readily hark back to the period immediately preceding the war. And all of them will take time to spread. Meanwhile, manufacturers will probably sell interim equipment embodying flashy features whose virtues are more apparent than real. Improved export models may be the major exception.

Less need for soft-pedaling is seen by the average electronic equipment manufacturer serving business rather than the general public. In the communications field, for example, much fixed station and more portable gear developed for the military services can be quickly altered to meet post-war needs of the commercial market.

Most makers of electronic industrial controls will continue unabashed to use visionary promotion, perhaps in more moderate doses. There are, on the one hand, innumerable potential users who need problems solved and don't know that tubes can solve them and, on the other hand, many electronic engineers who know precisely what tubes can do but don't know exactly what problems industry wants solved. Without continued searching for new applications on the part of the latter group it might be a case of "never the twain shall meet." Complicating somewhat the post-war program for this group of manufacturers is the growing realization that the search for new applications should henceforward be conducted without implying that a phototube nailed to a barn door will feed, currycomb and bed down the livestock. Without occasional frank admissions by the chief proponents of electronics that there are some jobs which tubes cannot do at all, and other jobs that are impractical, the cost of developing the industrial market from here in could easily be excessive. Further complicating the otherwise extremely rosy picture is the possibility that manufacturers may have to carry on a more or less perpetual search for specific control applications whose similarity permits volume production of elusive "package" items.

Parts manufacturers serving assemblers of both communications and industrial control apparatus appear to have the best reason for pulling out the stops and playing an exciting song about their post-war products. While some components developed for military use have no obvious commercial application, most of them are directly adaptable to peacetime jobs and will be available on the open market to people who are willing to pay a little more for substantial performance improvements. In many instances amortization of design and production machinery costs during the war should make improved parts available without increase in price.

New Competition

There is every reason to believe, manufacturers think, that expansion of the market for electronic gear after the war will be substantial and one of the major factors in the recovery of the nation. First, there will be much accumulated replacement business. Second, factories should be kept busy turning out apparatus with which to develop fields that started to blossom and then were frozen for the duration. Third, there will be the slower but less competitive job of pioneering entirely new ideas. All of these objectives should be made easier to attain by the fact that the efficacy of electronic equipment is now being dramatized by military applications. Thousands of men trained in the art by the armed forces will return with a more practical appreciation of how tubes can serve them in their work as well as in their homes. Then too, factories virtually forced to give tubes and other sensitive control devices a trial during the present emergency in order to speed up output while at the same time conserving manpower and materials, are becoming accustomed to using electronic equipment.

Expansion of the market, many executives think, will be particularly important in the initial post-war period to compensate for increased

(*Continued on page* 136)

QUESTIONS to Conjure With

HOW MANY electronic military developments are applicable to the commercial market?

HOW MUCH of this new gear will be kept under wraps indefinitely by the Army and Navy?

* * *

HOW DIFFERENT are broadcast receivers likely to be when the shooting stops?

HOW FAST will commercial application of UHF, VHF, FM and Television equipment expand?

* * *

HOW MANY of the proposed industrial uses for electronics will prove practical?

HOW MANY hand-tailored control applications have volume "package" possibilities?

* * *

HOW MUCH will the commercial market pay for parts with improved characteristics?

HOW MUCH expansion of demand will there be to compensate for new component competition?

* * *

HOW MUCH time will it take the industry to convert from wartime to peacetime production?

KTKC

By BERT WILLIAMSON

Chief Engineer, Station KTKC
Visalia, California

New transmitter building, with the 275-foot east tower in the background. Three large glass block windows in the control room provide ample light for daytime operation

THE STORY of how KTKC built its own transmitter dates back to July, 1937, when the station started broadcasting with 250 watts of power, daytime only, from a single building containing transmitter, studios and offices. A consistent policy of providing new and useful services for agricultural interests of central California brought its first reward in the form of a construction permit for 1 kw on 890 kc.

Permission for full-time operation was predicated on use of a directional antenna system, but the original 5-acre tract was not large enough for this purpose. No adjoining land was available, so a 17-acre tract a quarter-mile down the road was purchased and the new transmitter erected there. Offices and studios remained at the old site. For a few months after the new transmitter went on the air, everything was fine, but this was not to last. Granting of more power by the FCC to another station on the same frequency seriously curtailed the night coverage of KTKC and started a search for a new frequency.

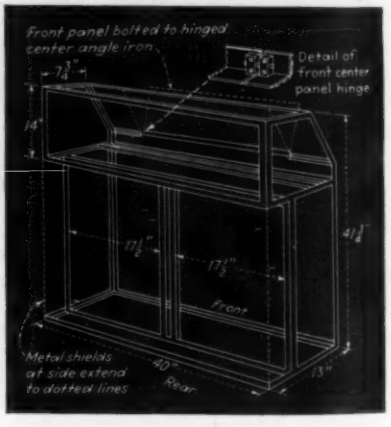
Ratification of the Havana treaty opened up 940 kc to U. S. stations provided protection was given to stations in Mexico City and Ontario. KTKC immediately applied for this frequency and for an increase in power. A construction permit was granted by the FCC in Sept. 1941, for 5-kw full-time operation with a directional antenna system, and construction of the new transmitter building was started immediately on the new 17-acre site.

Then came Pearl Harbor and the resulting skyrocketing of orders for military radio equipment. The manufacturers with whom orders for the transmitting equipment had been placed were contacted, as also were manufacturers of individual parts. It quickly became apparent that a much better chance of completing the project would be had by building rather than buying the equipment.

The only hope of success in building lay in finding the required component parts on dealer shelves. A whirlwind trip through the eastern manufacturing centers, buying everything available which could be used or adapted, finished up with nearly every required part either on its way to Visalia or with a definite delivery date assured. Most of these were standard items carried by wholesale houses or stocked by manufacturers. A great many of the purchased parts were those carried by dealers for construction of high-quality amateur transmitters.

Transmitter Circuits

From this collection of parts, a 5-kw transmitter had to be built. Circuits had to be designed for what was available, with no special parts which would be difficult if not impossible to obtain. Simplicity was the keynote in all circuit design, since experience had shown that the



Angle-iron framework of the master control console designed especially for KTKC requirements

Builds a 5-kw Transmitter IN WAR-TIME

When war shortages endangered completion of their long-sought new transmitter, KTKC engineers made a whirlwind shopping trip through the East for necessary parts, then built the entire 5-kw transmitter themselves in 105 days. Many amateur radio parts were used

Master control console in transmitter room, using many unique switching circuits designed and built by KTKC engineers

more complicated the equipment was made, the more chance there would be for trouble. A further complication was the fact that provisions had to be made to insure continued operation under the extremely high temperatures encountered during the summer months.

Fortunately, it was found possible to secure a complete Collins 40-E oscillator unit on a standard relay rack panel. By following this with a buffer stage using two 813's in parallel, the number of r-f driver stages was reduced by at least one. The Collins unit is fully capable of driving the 813 buffer stage, since these beam power amplifier tubes require almost negligible driving power. A single 892R in the plate-modulated power amplifier stage completed the r-f tube line-up, delivering the required 5 kw of power to the transmission line. The circuit arrangement is shown in Fig. 1.

The automatic equipment included in many 5-kw transmitters to reduce power to 1 kw was omitted in the interests of simplicity, and also because the old 1-kw transmitter would be available intact as an auxiliary unit as soon as the 5-kw job went on the air. Mechanical flags were installed to indicate overloads, in place of the customary electrical drops or interlocking signal lights, with a further reduction in parts and wiring.

The a-f section of the transmitter is more or less conventional in design. The input from the 500-ohm studio-transmitter line feeds the first a-f stage, using a pair of 6L6G's in push-pull. These in turn are resistance-coupled to a pair of 845's in push-pull, serving as the driver. The modulator likewise is push-pull, with a pair of 891R's which operate

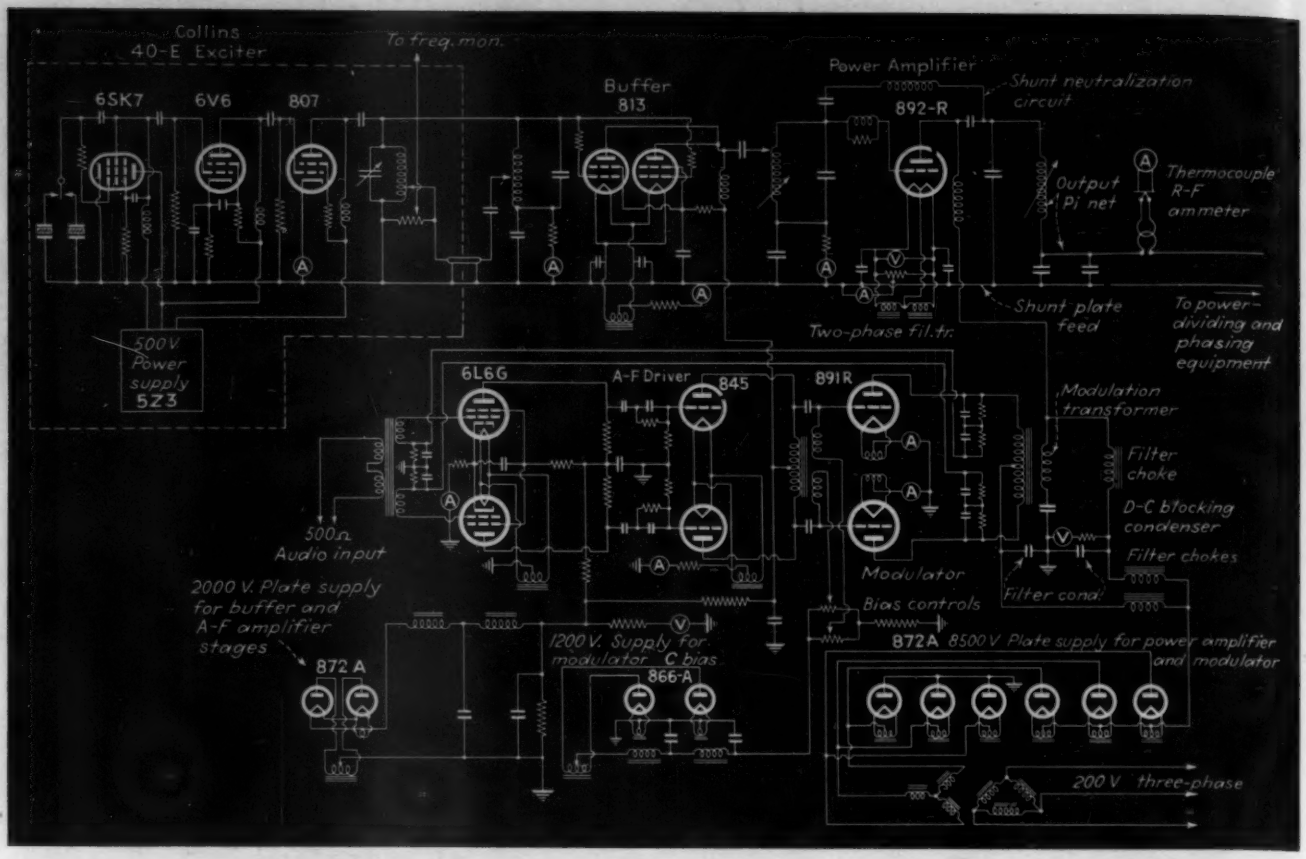


FIG. 1—Simplified schematic of the 5-kw transmitter built during war-time by KTKC engineers. It uses high-level modulation, with a modulator capable of supplying 2500 watts of audio power to the plate circuit of the type 892-R tube in the power amplifier

well within their power-handling capabilities when delivering the 2.5 kw of audio power required for 100-percent modulation. Inverse feedback voltage fed to the first a-f stage is obtained from the plate circuits of the modulator tubes, to flatten the response of the entire a-f section.

Circuit simplification had the additional advantage of simplifying layout problems. Controls were installed in the most efficient positions from an electrical standpoint, and mechanical linkage or flexible shafts used to secure symmetrical groups of controls on the panels. So well did the final layout of parts work out that it is now possible to remove any desired part without first removing other parts.

Protection Provisions

All primary power circuits are protected with either circuit breakers or fuses, and meters are installed at appropriate points to indicate abnormal circuit conditions. The protective equipment is in general quite conventional, the newsworthy fact being that the required meters and overload devices actually were obtained in war-time by diligent search.

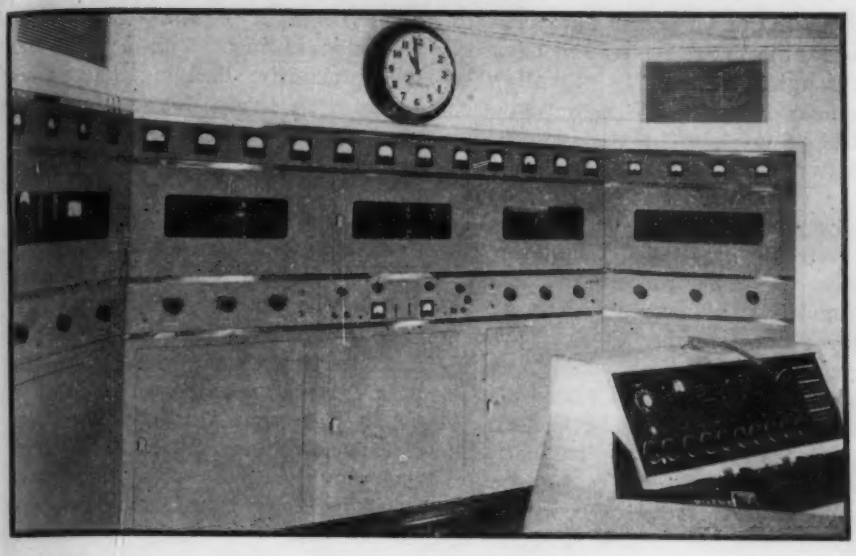
Many new transmitters have automatic overload reset systems, which give the circuits a definite number of chances to get back to normal before cutting off the power permanently. The commercial version was not obtainable, but a highly satisfactory improvisation was worked out with easily obtainable parts centering around a "Coto-Coil" ratchet switch originally designed for automatic changing of bands on amateur transmitters. This switch has two banks, each with four contacts 90 deg. apart. Contacts 1, 2 and 3 are tied together and 4 is unconnected in one bank.

Each overload relay in the transmitter has one pair of normally-open contacts and one pair of normally-closed contacts. The normally closed contacts are all in series with the auxiliary starting contactor for the 8500-volt main power supply, while the normally open contacts are in parallel and are so connected that when an overload occurs, one pair of these contacts will close and energize the ratchet switch coil. This moves the switch arm up 90 deg., to contact 2. Contacts 1, 2 and 3 are all connected to another relay which closes the "plate start" switch, so power is reapplied to the main rectifier.

If the overload still exists, the circuit overload relay will open again and the ratchet switch arm will move to contact 3. If the overload relay again trips, the ratchet switch arm will move to unconnected contact 4, and power will stay off. The "plate start" button must then be operated manually to put the carrier back on the air. The second bank of contacts on the ratchet switch is used to operate indicator lights which show the position of the switch at all times.

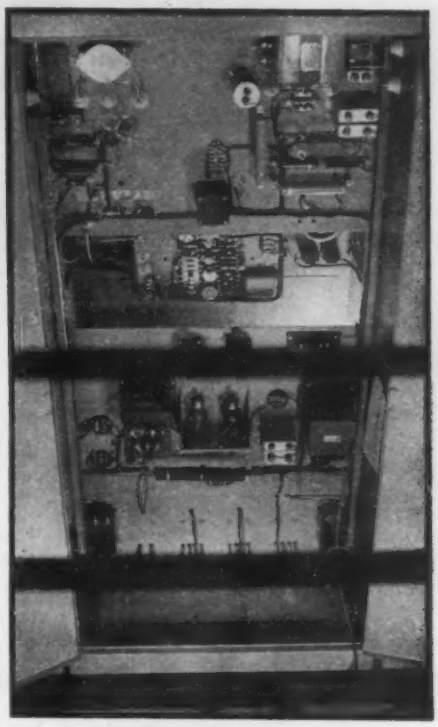
Transmitter Cabinets

The five cabinets which make up the 5-kw transmitter are designated as 1, 2, 3, 4 and 5 on the transmitter building floor plan in Fig. 2. These cabinets are set on 4x4 inch timbers which form a base and provide space for the cable trench under the cabinets. The front timbers, visible from the control room, were sur-



Stainless steel trim strips were used to give transmitter panels the appearance of a single manufactured unit

Rear view of r-f and a-f exciter cabinet, built so any part can be removed without disturbing other parts



faced and painted telephone black to give the appearance of a metallic base for the cabinets.

The cabinets themselves were made up from 14-gauge auto body steel, in an extremely simple design. The use of modernistic stainless steel trim strips, running horizontally across all five cabinets, gives the illusion of a single front panel.

No attempt was made to include fancy dials or indicating plates on the panels. All controls were installed on a narrow panel of ☆-inch dural backed with steel. Engraving placed on the lacquered dural panels stands out without filling.

The backs of cabinets 2, 3 and 4 face into a screened room enclosing also the separately mounted high-voltage components. The door of this screened room and the doors of cabinets containing high-voltage circuits are electrically interlocked

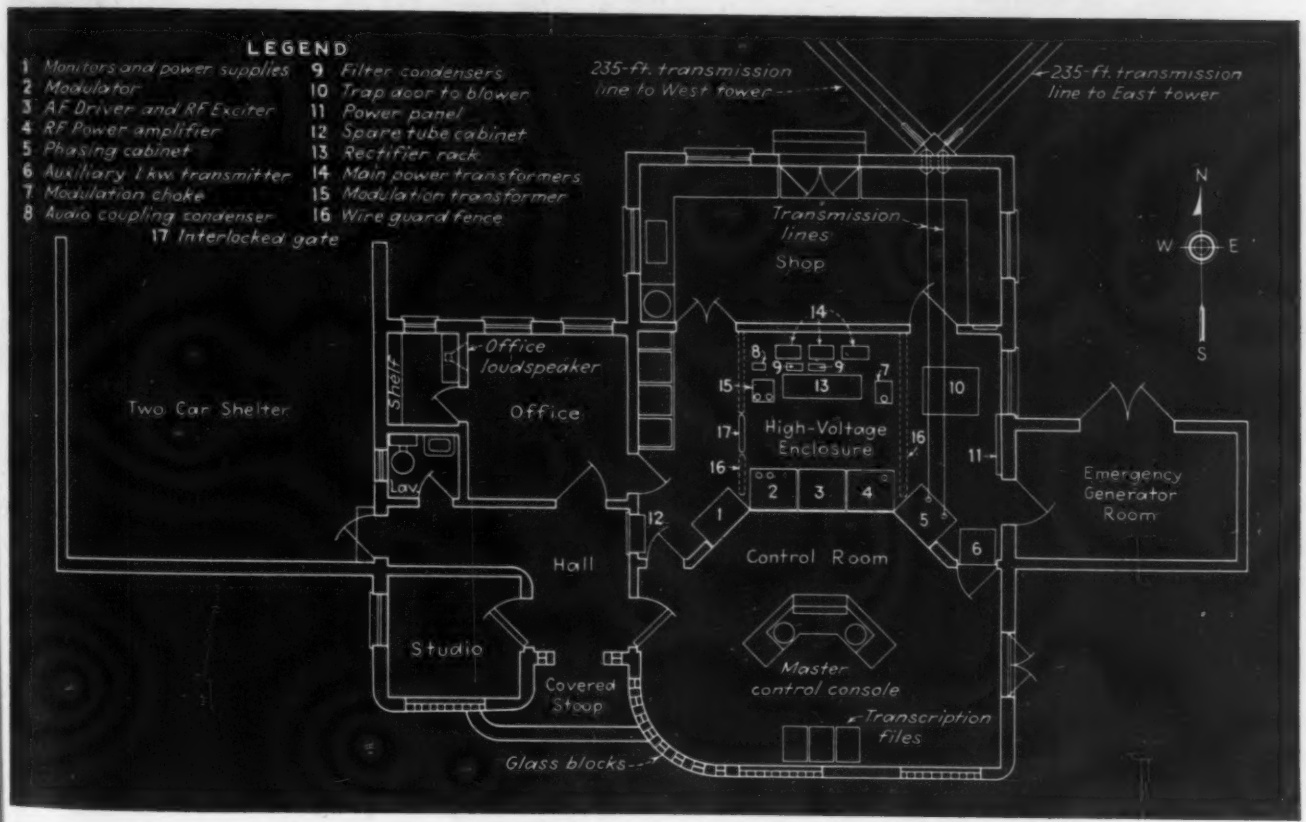
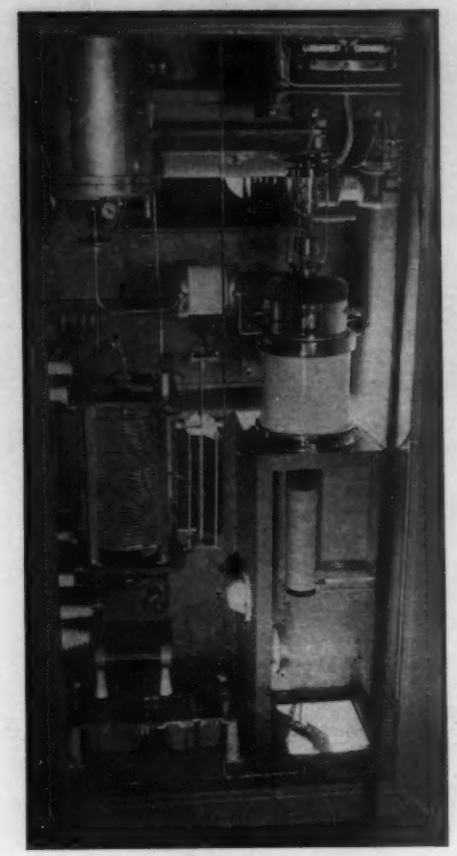
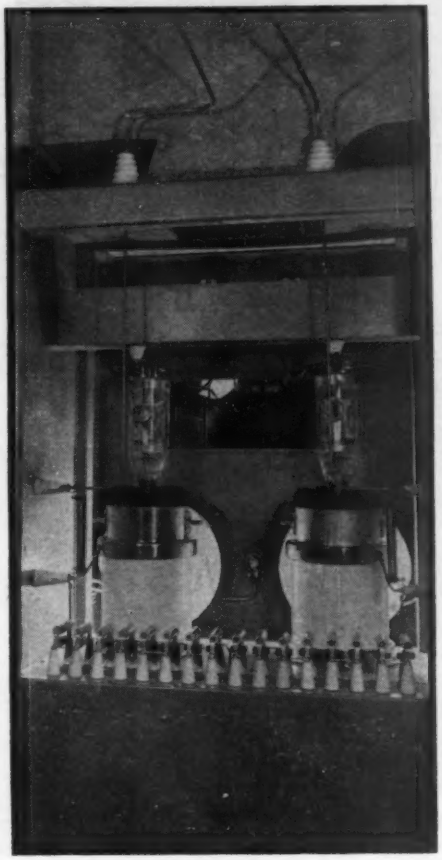


FIG. 2—Floor plan of the new KTKC transmitter building. From the master control console a single operator-announcer can handle transcribed programs himself



Rear of r-f power amplifier cabinet, showing the 892R tube with the air-cooling duct and the ingenious "home-made" air-failure mercury switch on a Masonite vane below the tube. At the upper left is a gas-filled tank condenser



Rear of modulator cabinet, with the two air-cooled 891R tubes. The ducts which pull heated air up from the tubes in winter for heating the building can be seen above the cabinet. The voltage divider bank provides the feedback voltage

so as to cut off power automatically and discharge filter condensers through a resistor to ground when a door is opened. Screen was used instead of a solid wall to provide better ventilation and cooling for the rectifiers, filter condensers and power components.

Air cooling for the modulator and power amplifier tubes is provided by a multi-vane blower driven by a ¾-hp three-phase motor. A duct system running under the transmitter cabinets brings the air to each tube. A by-pass shunts part of the air to the r-f and a-f exciter cabinet. All air is filtered through a two-section spun glass filter to reduce accumulation of dust on the tube-cooling fins and on insulators.

A synchronous clock relay is connected to the blower to keep it running after the transmitter has been shut down. The time is adjusted according to the season, to give complete cooling of the heavy copper fins on the 891R and 892R tubes.

The method of cutting filament and plate power automatically in case of air failure is extremely simple, consisting only of mercury switches mounted on pivoted Masonite vanes located in each modulator and power amplifier tube duct.

Heating ducts for the building are so arranged that in winter the heated air from the large transmitter tubes can be used for heating purposes. In the summer, however, this air is pulled out of the transmitter room by a ceiling ventilator, and cooler air is pulled up from the sub-basement by a suction fan.

Directional Antenna System

Two insulated self-supporting towers spaced 349 feet apart are used. To maintain the necessary depth of nulls and their correct orientation in the radiation patterns as required to protect Canadian and Mexican stations, the west tower is 215 feet high and fed with a current of 9 amperes, while the east tower is 275 feet high and fed with 6.75 amperes. The two currents differ in phase by 76 deg.

Power-dividing and phasing equipment is in a separate interlock-protected cabinet (5 in Fig. 2) in the transmitter building, and is so designed that small touch-up adjustments can be made during the regular broadcast schedule with power on. From here power is carried to each tower by six-wire open transmission lines. At the base of each tower is a metal doghouse having a floor area of 4x6 feet, large enough for a man to enter and close the door. These large metal tuning houses were found to be a great improvement over the usual tuning boxes, in the reduction of capacity effects encountered when removing the covers for adjustments. Each doghouse contains an a-c outlet (highly convenient when an oscilloscope is to be used) and lights for convenience in making adjustments at night.

Master Control Panel

Since routine operation is carried on with combination operator-announcers, it was decided that the logical place for the master control panel was in the transmitter building. Like all other cabinets, the master control console was designed and built especially for the job. The frame is made entirely from angle iron in a simple design. It has a sloping front on which is mounted the master mixer panel, patch panel and various relay and talk-back controls.

The frame itself supports two standard relay racks on which are mounted standard audio amplifiers. A horizontal channel directly back of the mixer panel supports the rubber-mounted preamplifiers and the pre-program amplifier. The entire framework is enclosed with natural-finish maple, giving a single compact unit of modern design.

Two Presto 6-D 16-inch turntables with their associated RCA vertical-lateral reproducers, orthacoustic filters and standard filters are mounted on the console. Directly in front of the operator and flush with the top of the operating desk is a UTC 3AX equalizer. Horizontal partitions for 16-inch electrical transcriptions were built into the wings, with vertical compartments below for storage of 10 and 12-inch advertising records or transcriptions.

The announcing microphone is mounted on a flexible "gooseneck" directly above the mixer panel. Many other features add to the prac-

ticality and convenience of this master control console in putting on a "one-man show" during those hours when announcements, recordings and transcriptions make up the program.

Program-Switching

Local programs can originate from four points—the master control in the transmitter building, the news studio in a newspaper office in Visalia, a special studio in Fresno (39 miles northwest of Visalia) and the main studios in the original transmitter building a quarter-mile from the new transmitter. In addition, Blue network programs come directly to the master control panel. This variety of pick-up points made it necessary to develop a rather unorthodox system of studio and speech control.

All remote lines, including the Fresno studio line, terminate at a 25-point rotary selector switch located in the news studio in Visalia. This switch is operated by a standard telephone dial mounted at the upper left of the master control mixer panel, so that the operator at the main transmitter can switch any remote circuit at will to the equalized loop connecting the news room to master control. In addition, the operator can select either news room studio and turn on its associated speech amplifier by means of this dial selector. Automatic telephone technique was thus effectively applied to secure true master control with a minimum of telephone lines between studios.

A simple and fool-proof talk-back or cue system was devised so the master control operator could communicate by a push-to-talk method with any studio or remote terminated at the news room rotary switch. The entire system was built up with standard relays and keys. The talk-back relays can be operated only when the master mixer keys are in audition positions, hence it is impossible to break into a line which is feeding a program to the transmitter. Since this system allows cueing only up until air time, all portable remote amplifiers contain a small built-in receiver which permits the remote operator to air-check his program in addition to checking the outgoing line.

The main studio, studio control room, lobby, production office and manager's office each have an amplifier and monitor loudspeaker, with a rotary switch to make connections to audition, Blue network bus or the program on the air at that time.

Continuous air check is made at master control with a monitor amplifier permanently connected to a monitor loudspeaker in the transmitter room. This amplifier normally receives its a-f input from a diode rectifier fed by a short aerial which picks up the station signal and thus gives a check on the program actually going on the air. A non-locking key is provided to connect the input to the transmitter line for a comparison check if desired.

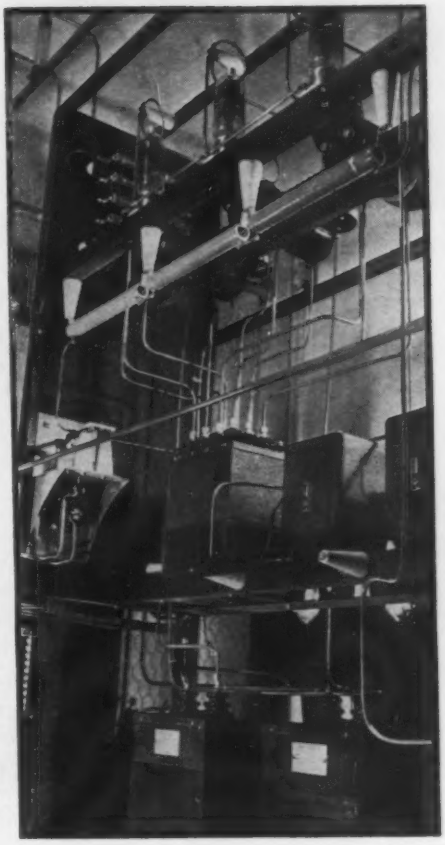
To provide for feeding local programs to the Blue network from the transmitter or for feeding to the main studio for recording on the professional recorder there, an additional bridging amplifier was installed. Its input is connected to a 11-point rotary switch so any desired circuit can be picked up without affecting the program on that circuit. The output of this amplifier can also be connected to the recording attachment on the left-hand turntable at the master control.

To reduce loading effects caused by bridging the Blue network line at the main studio, a net-dividing amplifier is used. Loading or even shorting of one line will not affect the other.

Over-all Performance

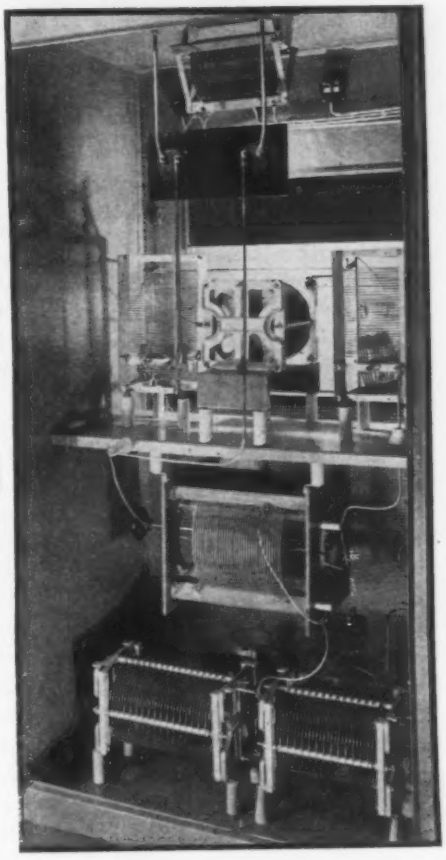
The over-all response of the new KTKC transmitter is flat within plus-or-minus 1 db from 40 cycles to 12,000 cycles. Distortion at all audio frequencies is thus well under the FCC limits for broadcast stations. Operating costs for the new 5-kw transmitter are only about 20 percent higher than for the 1-kw transmitter.

All in all, the performance of this war-time-built transmitter has been highly satisfactory during its more than 5,000 hours of service. Only four interruptions have occurred to date due to technical difficulties, and three of these were during the first month of operation. Much credit for this record is due to manufacturers who constructed their equipment exactly according to specifications and met delivery promises in spite of difficult war-time conditions. The station went on the air 105 days after the cabinets arrived.



This open-side power frame, in the screened enclosure behind the cabinets, supports main and buffer rectifier parts

Below—Rear view of phasing cabinet



Electronic Tubes for ULTRAVIOLET

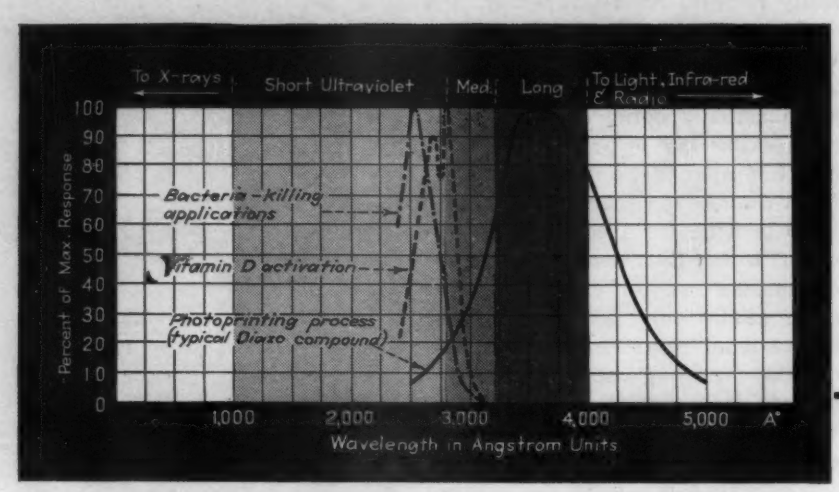


FIG. 1—Spectral response curves for three important applications of ultraviolet radiation. The peaks of the curves represent the most effective wavelengths

Like other electronic devices, ultraviolet tubes using a discharge in mercury vapor require application engineering. This paper takes up the various factors involved in select-

THE modern electrical engineer who is familiar with electromagnetic waves ranging in wavelength from many thousand meters down to a few centimeters often has a decidely less clear concept of that part of the electromagnetic spectrum which covers the ultraviolet radiations. Yet, many of the basic concepts applying to electromagnetic waves are equally useful in the field of ultraviolet radiations. Whereas the present lower limit for radio wavelengths is around one cm, the ultraviolet spectrum ranges from about 0.000 000 04 cm down to about 0.000 000 01 cm (from 4000 Angstroms down to 1000 Angstroms.)

It has been found helpful to subdivide this ultraviolet range into two or three smaller ranges. The range from 4000 Angstroms down to about 3200 Angstroms is called the "long ultraviolet", the range from 3200 Angstroms to 2800 Angstroms is called the "medium ultraviolet", and ultraviolet wavelengths shorter than 2800 Angstroms are called the "short ultraviolet". This subdivision is not entirely arbitrary, as certain specific effects of ultraviolet rays are predominantly concentrated in each of these regions.

To mention a few examples, some photo-chemical processes, such as photo-printing, react very strongly to the long ultraviolet. The activation of vitamin D in sterols uses the range from 2400 to 3000 Angstroms. The short ultraviolet waves are highly effective in destroying microorganisms and are therefore useful for bactericidal applications. The wavelengths giving optimum results in these three important commercial processes are indicated by the spectral response curves in Fig. 1.

Once the spectral response of a process has been obtained by plotting on a percentage basis the effectiveness of each ultraviolet wavelength, a generator of ultraviolet radiations can be selected or specially designed to give the most efficient and economical results for the particular application in mind.

The importance of choosing the most suitable ultraviolet source and of matching the spectral emission characteristics of the source to the spectral response characteristics of the process to which it is to be applied can hardly be emphasized enough. Indeed, many a project involving the application of ultraviolet rays may have been abandoned prematurely because its originators failed in thoroughly investigating the problem of selecting or designing the ultraviolet generator best suited for their project. As an example, it might be mentioned that the abiotic (death-producing) effects of ultraviolet radiations had been known for many years before it was recognized that in the low-pressure mercury vapor lamp there was available a highly efficient and economical source of bactericidal radiations which is

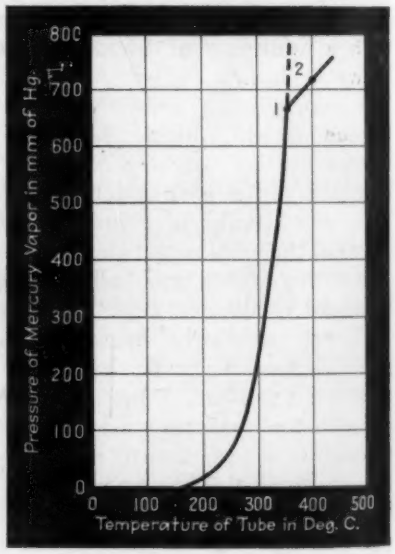
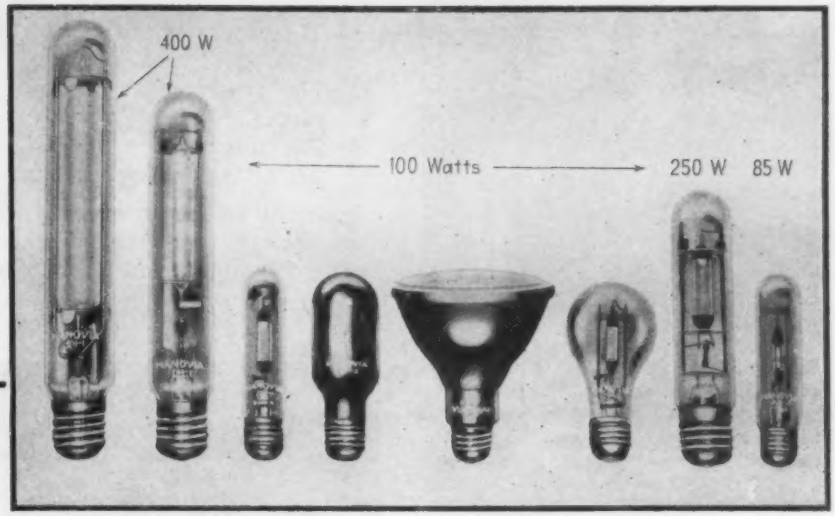


FIG. 2—As the temperature of the envelope of the mercury vapor tube increases, the resulting vaporization of liquid mercury makes vapor pressure increase rapidly up to point 1, where all mercury has vaporized. After that, pressure is directly proportional to temperature

RADIATION

By J. H. LAUB
Hanovia Chemical and Mfg. Co., Newark, N. J.

ing the best tube for a particular industrial or medical job and explains the practical relations between gas pressure, temperature, wavelength and radiation output



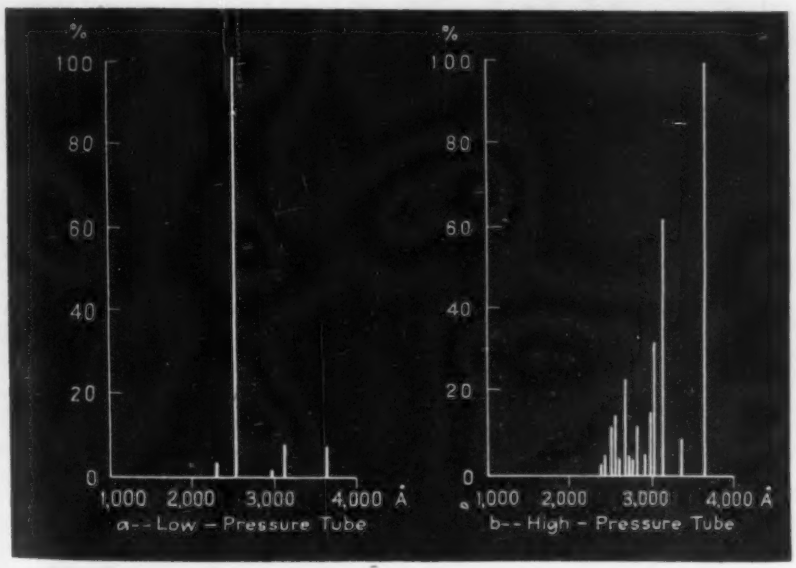
Examples of high-pressure mercury vapor tubes. Typical applications are printing of film copies, sound track recording, fluorescent activation, and manufacture of organic halogenation products

eminently suited for installation and operation on a large scale.

Before discussing the different types of electronic tubes for generating ultraviolet radiations, it is well to remember that coming from the long-wave end of the spectrum of electromagnetic oscillations the distance between two successive nodes of the waves becomes smaller and smaller, and finally in the ultraviolet range approaches the internal dimensions of the molecule. This explains why ultraviolet rays can act so powerfully on atoms and molecules of certain substances, bringing about physical changes in the atomic structure or in the arrangement of the molecules and thus resulting in changes in the chemical or physical construction of the substance.

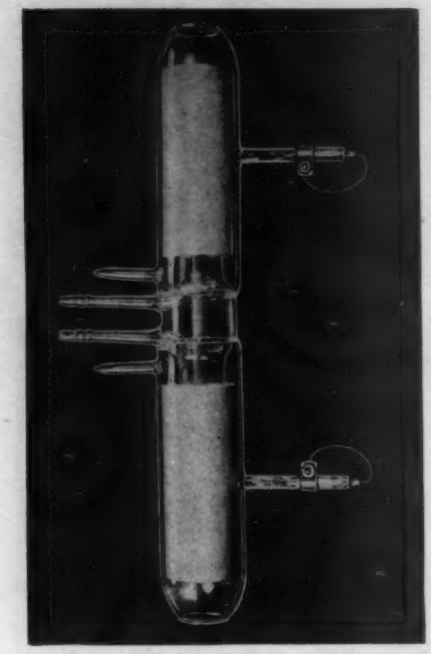
Electromagnetic oscillations at the long-wave end of the spectrum can be produced by periodically oscillating electrical charges in circuits and circuit elements, and can be guided to their destination by wires or wave guides and radiated into space by antennas. In the ultraviolet range of electromagnetic waves, however, it is necessary to excite the atoms or molecules of gases or vapors by electronic bombardment, and rely on the emission of energy radiated by the transition of boundary electrons from higher energy levels to lower ones. The electronic ultraviolet tube thus becomes generator, guide and antenna for electromagnetic waves all in one.

FIG. 3—Effect of pressure on the distribution of spectral energy radiated by a mercury vapor tube



Effect of Gas or Vapor on Emitted Radiation

If we now turn to the question of what determines the spectral distribution, quantitatively and qualitatively, of the radiation output of an ultraviolet generator, it is obvious that the nature of the gas or vapor whose molecules are excited by the electric discharge passing through it will have an important influence on the character of the emitted radiation. The structure of the gas atom,



Hydrogen discharge tube which operates at an input of about 1 kw and a gas pressure of 2 mm. Cylindrical aluminum electrodes are used, and water cooling is required to keep the gas pressure sufficiently low

namely the number and arrangement of the boundary electrons rotating around the nucleus, will determine the possible transition processes of the electrons from one energy level to another.

The frequency ν of the radiation which is emitted owing to the transition of an electron from one orbit with an energy level W_2 to an orbit with an energy level W_1 can be calculated from the quantum equation $h\nu = W_2 - W_1$, where h is Planck's constant. Also, the density or pressure of the vapor or gas through which the discharge passes has an important bearing on the spectral energy distribution, since the excitation processes are caused by collision of electrons and ions with the atoms of the gas and the probability of such collisions depends on the number of atoms per unit of space, i.e. the density of the gas.[1]

Factors Affecting Wavelength

The ultraviolet rays generated by excitation processes have to travel first through the gaseous atmosphere until they reach its boundary, then through the envelope which encloses the discharge and through gaseous or solid media, filters, etc. before they reach the substance on which they are supposed to act. Obviously the absorption and reflection characteristics of all these media interposed between the source and the destination of the ultraviolet rays will affect again the quantity and quality of the radiation at the "receiving end."

Thus we have briefly enumerated three of the major factors determining the spectral characteristics of the output of an ultraviolet generator, namely:

1—The nature of the gas (or vapor).
2—The pressure of the gas (or vapor).
3—The transmission characteristics of the envelope.

Inasmuch as this paper deals with electronic tubes we propose to confine the following discussion to those types of ultraviolet sources in which

High-pressure mercury vapor tube 5 feet long, with rated input power of 4.5 kw, for use in a blueprint machine

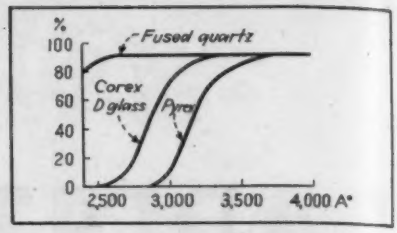


FIG. 4—Spectral transmission characteristics of three materials commonly used as envelopes or filters for mercury vapor tubes. Note that both Corex D and Pyrex pass very little ozone-producing short-wave ultraviolet (around 2500 Angstroms)

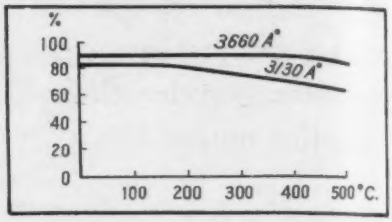


FIG. 5—Effects of temperature on transmission characteristics of Corex D glass at two different ultraviolet wavelengths

an electrical discharge or arc is enclosed in a tubular envelope transmittant to the ultraviolet radiations. We therefore leave out of consideration the open arcs such as carbon arc lamps and spark discharge devices, which cannot be classified as electronic tubes though they have in certain fields found practical applications as ultraviolet generators.

The electronic tubes which will be discussed here have a number of outstanding advantages over open arcs. For instance, the much higher efficiency in transforming the electric energy input into ultraviolet radiation output and the greater ease of installing, cleaning and handling greatly facilitate the wide-spread use of electronic ultraviolet tubes in commercial and therapeutic applications.

Types of Gases Used

A number of substances are available which in their vapor or gas phase can be excited by an electrical discharge to emit strong ultraviolet radiations. Other considerations, however, such as the required operating temperature of the envelope or chemical reaction of the envelope with the gas greatly limit the number of substances that are practical as fillings for ultraviolet tubes.

Hydrogen gas is applied on a lim-

ited scale in discharge tubes of fused quartz for laboratory use. The continuous spectrum characteristic of hydrogen extends over the entire range of ultraviolet (short, medium and long). It constitutes a very convenient source of ultraviolet of any desired wavelength, but has relatively small energy output. So far, hydrogen discharge tubes have only limited application.

Cadmium metal has been used as a filling in bulbs of fused quartz for therapeutic ultraviolet lamps. In its vapor phase, cadmium can be excited by an electrical discharge to emit strongly in some ultraviolet bands, notably 3610, 3466 and 3404 Angstroms. It may thus be used as a fairly efficient source of long-wave ultraviolet radiation. In the medium ultraviolet and short ultraviolet ranges, however, the output of the cadmium arc is inferior to that of the mercury arc and consequently a higher input of electrical energy is required to produce the same output in these important ranges.

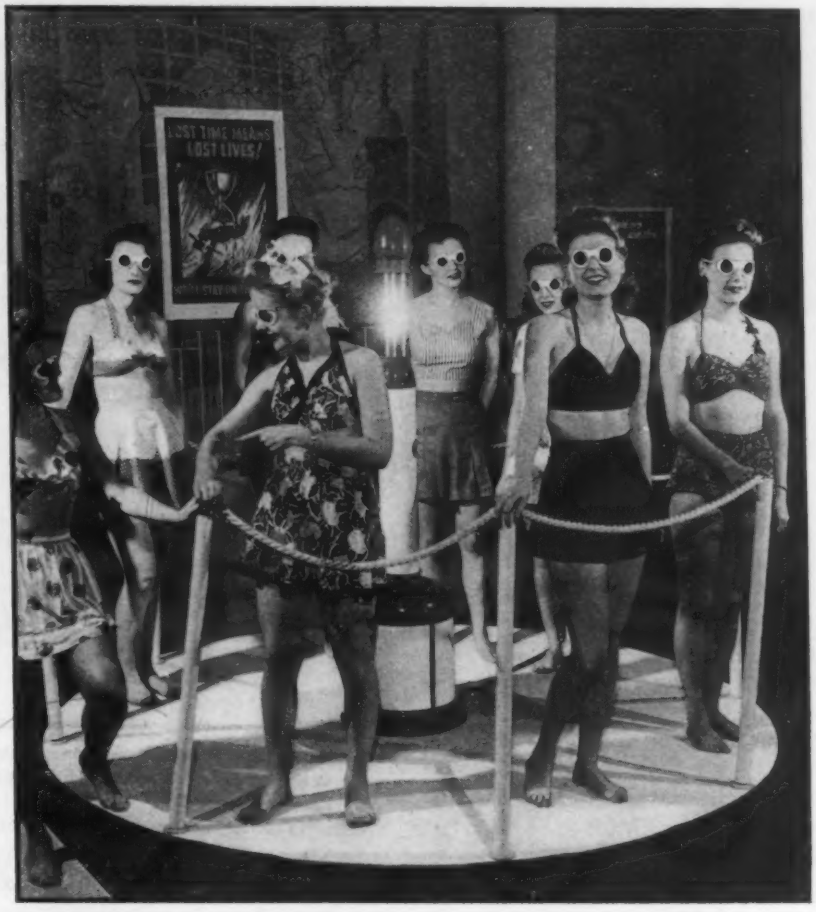
We now turn to mercury vapor—the medium for exciting ultraviolet radiations which has attained by far the greatest importance and the widest application of all available filling substances. When mercury vapor of suitable pressure is excited by an electric discharge, it offers the most efficient and economical source of ultraviolet radiations of a wide variety of wavelengths. Inasmuch as the pressure of the mercury vapor has a very important bearing on the spectral energy distribution of the emitted radiation we shall first briefly discuss its influence.

Influence of Pressure

The mercury vapor tubes with which we are dealing here consist essentially of an evacuated envelope of quartz or glass into which a small amount of mercury has been sealed in manufacture. The pressure of the mercury in the vapor phase depends on the temperature of the mercury in the liquid phase as long as a liquid phase exists, i.e., before all of the mercury has been evaporated. This is illustrated by the curve of Fig. 2, in which pressure of mercury vapor is plotted against temperature. At temperatures below about 100 deg. C the pressure is very small; for instance, at 20 deg. C it is 1.2×10^{-3} mm Hg, and at 40 deg. C it is 6.1×10^{-3} mm Hg. At higher temperatures the pressure rises rapidly, and reaches 1 atmosphere (760 mm Hg) at 356.7 deg. C.

As the temperature is increased a point is finally reached (point 1 in Fig. 2) at which all the mercury originally sealed into the tube is evaporated. If the temperature is increased beyond this point the mercury becomes unsaturated and practically follows Gay-Lussac's Law. The pressure then rises in proportion to the absolute temperature of the wall. This is illustrated by the straight solid line 1–2 in Fig. 2.

It is worth noting here that the slope of the solid line 1–2 is much less than that of the saturated branch. This means that a mercury vapor lamp which operates in the unsaturated state (with all the mercury evaporated) is less sensitive to fluctuations in temperature than a lamp operating in the saturated state



Demonstration of new high-pressure quartz ultraviolet unit developed for the merry-go-round system of irradiating workers in defense plants. The pedestal-type mounting provides uniform distribution of rays in all directions. Automatic exposure timing is obtained either by rotating the platform at the rate of one revolution in five minutes, or by having the workers walk once around the lamp in five minutes

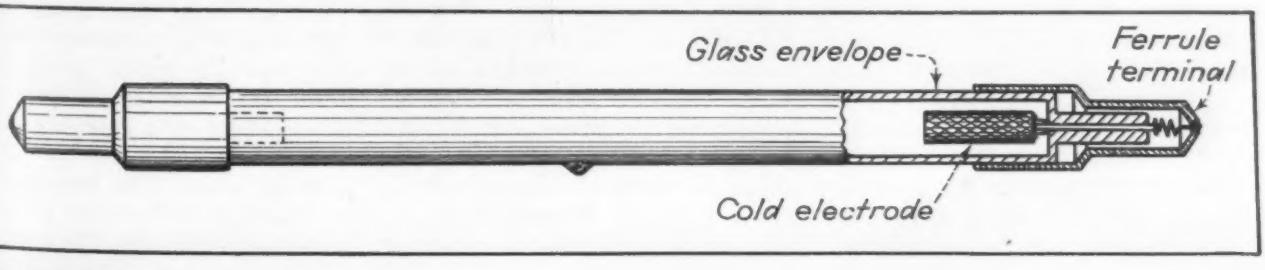


FIG. 6—Construction of a low pressure mercury vapor tube using cold electrodes

(with an excess of mercury in the liquid phase).

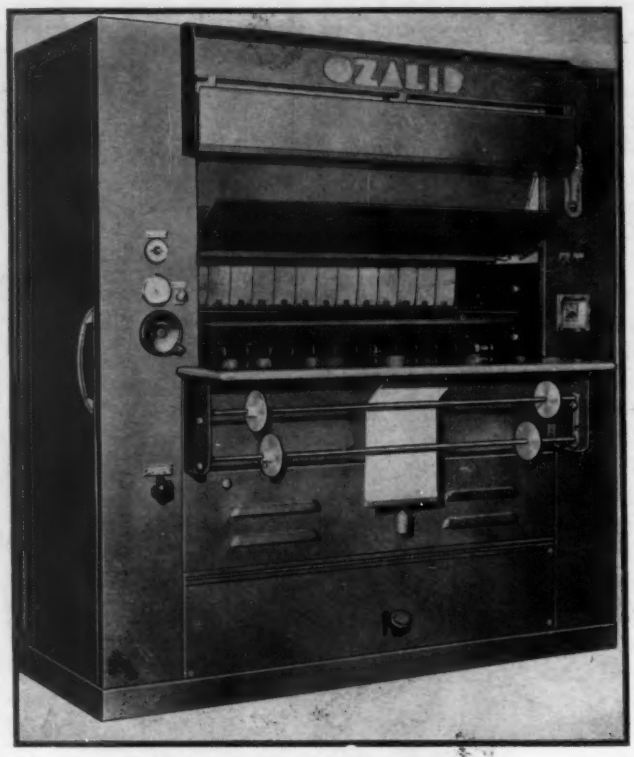
We are now ready to discuss the effect of the pressure of the mercury vapor on the spectral distribution of the emitted radiation produced by an electrical discharge. If we consider a typical low-pressure discharge at 0.01 mm Hg and plot the relative energy distribution versus the wavelength, with the help of a quartz monochromator, we obtain the diagram in Fig. 3A. Here almost the entire output is concentrated in one line, namely, 2537 Angstroms, the resonance line of mercury; the intensity of the other lines in the ultraviolet (for instance 2967, 3130 and 3660 Angstroms) is almost negligible.

If we now measure the energy distribution of the radiation output of a typical high-pressure mercury arc at 800 mm Hg, we obtain the result shown in Fig. 3b. The 2537 line carries relatively little energy under this condition because the resonance radiation is strongly absorbed by the atmosphere of high vapor pressure between the axis and the wall of the tube. There are strong lines in the medium ultraviolet, such as at 2804, 2967, 3130 and others, and the maximum intensity is associated with the 3660 band of the long ultraviolet range.

While the diagrams of Fig. 3 clearly indicate the qualitative difference between a high-pressure and a low-pressure discharge, additional information is required on their respective quantitative outputs. We refer again to Fig. 2, which shows that a relatively high wall temperature (several hundred deg. C) is required to produce a high pressure in the discharge tube, whereas low temperatures are associated with the low-pressure range.

Obviously a very much larger wattage is required to maintain the high envelope temperatures of a high-pressure tube than is necessary in the case of a low-pressure tube with its low temperature. High-pressure tubes consequently operate on wattages ranging from about 20 watts per inch of radiant length to about 150 watts per inch, while low-pressure tubes operate with loadings of 1 watt per inch and less.

Quantitatively, therefore, the output in ultraviolet radiation per inch of radiant length of a high-pressure tube is higher by one to two orders of magnitude than that of a low-pressure tube. If we consider further that the efficiency of transforming the electrical input into radiation output increases with rising pressure, it becomes obvious that a great number of low-pressure tubes would have to be employed to produce the same total radiation output as that produced by one high-pressure tube. Let us consider two examples. The total ultraviolet radiation output from one low-pressure quartz mercury vapor tube (Hanovia Safe-T-Aire Type) with a radiant length of 12 inches and operating at 8 watts input amounts to 1.2 watts. A high-pressure quartz tube with a comparable radiant length of 12 inches (Hanovia Type LL) and operating at 1275 watts input has a radiation output of 263 watts in the ultraviolet range. The high-pressure tube, therefore, is producing 220 times as much ultraviolet energy as the low-pressure tube, the ratio of the input wattages being 160:1. Fortunately, the intensities required in the destruction of micro-organisms and the other applications of low-pressure tubes are so low so that efficient installations can generally be made with a small number of tubes.



High-speed photo-printing machine which uses a high-pressure mercury vapor tube

Envelopes and Filters

The quality and quantity of ultraviolet radiation which can be utilized at the "receiving end" finally depends on the transmission characteristics of whatever media are interposed between the discharge and the substance on which the ultraviolet rays are supposed to react. This includes the enclosure of the discharge and any filters which may be used.

The temperature curves for three of the materials frequently used for envelopes and filters, namely fused quartz, Corex D glass and Pyrex, are shown in Fig. 4.

The temperature of the glass also has an important bearing on its transmission. The transmission of Corex D glass in the two bands, 3660 and 3130 Angstroms, is plotted versus temperature in Fig. 5. It is interesting to note that the transmission to radiation of 3130 Angstroms drops from about 82 percent at room temperature to 75 percent at 300 deg. C and to 70 percent at 400 deg. C—a fact which should be remembered if Corex glass is to be used in close proximity to high-pressure arcs.

Low-Pressure Tubes

In order for a low-pressure tube to be an efficient generator of short ultraviolet, it must have an envelope which is highly transmittant to the 2537 band at the relatively low temperatures at which low-pressure tubes are operated. Either pure fused quartz or a special glass developed by the Corning Glass Works is being used. The enclosure can be shaped to fit best the particular purpose to which the tube is applied

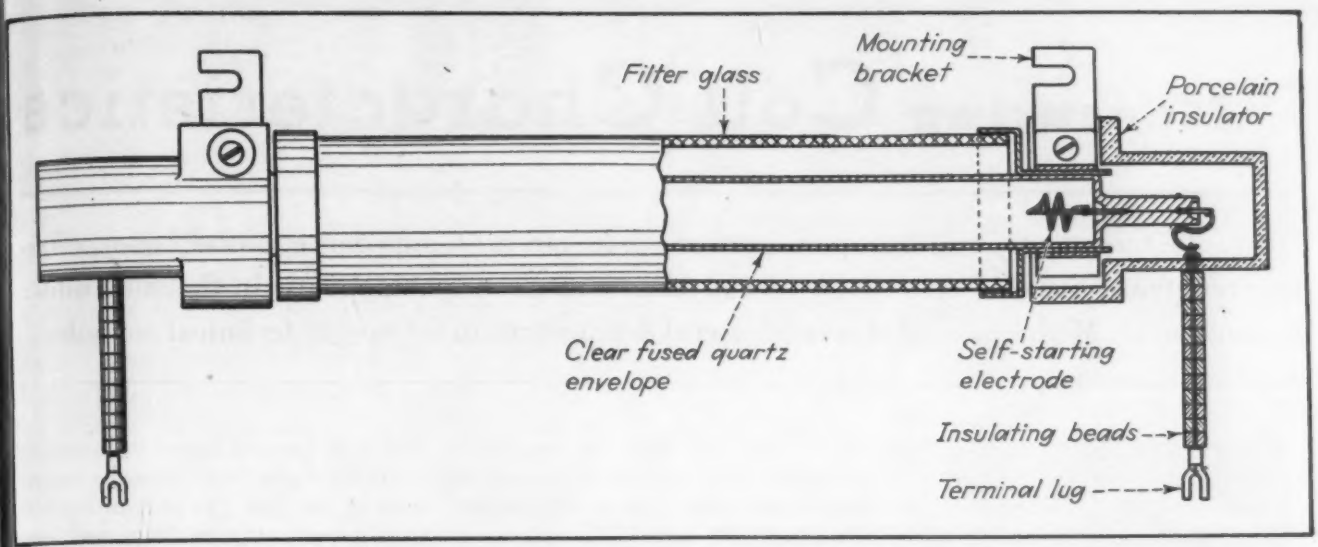


FIG. 7—Construction of a high-pressure mercury vapor tube. Here ionic bombardment heats the self-starting electrode

It may be in the form of a helix, a "Z" or a grid, but straight tubes about a foot or more in length and approximately one-half inch in diameter are commonly used.

Into the ends of the tube are sealed electrodes which may be either of the self-starting "cool" type or the activated "hot" type. In the latter case the tubes are operated at a relatively low voltage, about 50 to 60 volts between the electrodes and a current of 200 to 300 ma. If "cold" electrodes are used an open circuit voltage of 1000 volts or higher is required to start the discharge, and a voltage of several hundred volts is needed to maintain a current of about 30 ma. To facilitate starting, the tubes are filled with a rare gas, such as argon at several mm pressure, in addition to the mercury whose vapor is excited to emit the ultraviolet rays. Figure 6 shows the construction of a low-pressure tube with "cold" electrodes, the enclosure of which may be made either of quartz or glass transmittant to the short ultraviolet.

Low-pressure mercury vapor tubes have in recent years found widespread use for bactericidal applications, such as for destroying pathogenic organisms in the air of operating rooms or for preventing cross-infection in wards of hospitals or class rooms of schools. Special fixtures of various types have been designed to insure maximum coverage and efficiency of their radiation output. A low-pressure tube with a wattage input of 8 watts and a radiant length of 12 inches, when properly installed to irradiate approximately 3000 cubic feet of air, will have a sanitary effect equivalent to a ventilation rate of 50 to 100 air changes per hour.

Clinical evidence for the effectiveness of these tubes has been published. Amongst others, Dr. Richard Overholt and Dr. R. H. Betts report a 6 to 1 reduction in the incidence of clinically significant wound infections after thoracoplastic operations upon installation of Safe-T-Aire type low-pressure tubes in the operating rooms of two hospitals.[3] Tubes of this or a similar design are also used to control the air in meat packing plants, bakeries, pharmaceutical plants and other industrial plants where contamination of the air with micro-organisms frequently offers a serious problem.

High-Pressure Tubes

Mercury vapor arc tubes which are operated at an internal pressure of about one atmosphere or higher and at loadings of about 20 to 150 watts per inch were first introduced as ultraviolet generators for therapeutic and prophylactic use, but have become in recent years a very important tool for a number of industrial applications of ultraviolet. Two types that are widely used will be briefly described.

The essential constructional features of a straight cylindrical high-pressure tube of a type which has been developed with a radiant length of up to five feet and an input of up to 4½ kw are shown in Fig. 7.[3] The arc is enclosed in a cylindrical envelope of clear fused quartz into the ends of which are sealed the self-starting electrodes of coiled tungsten wire. They are coated with an activation material, generally a mixture of free barium and barium oxide, which has the effect of lowering the work function of the electrodes. It is thereby possible to operate the electrodes at a considerably lower temperature (about 1000 deg. C). If no activation material were applied to tungsten electrodes, they would require an operating temperature of about 2800 deg. C.

The rate of evaporation of tungsten at 2800 deg. C is many times higher than at 1000 deg. C. As a consequence, the inside wall of the enclosing arc tube becomes, after a relatively short period of operation, coated with a layer of tungsten which decreases markedly the useful radiation output. Comparative measurements of the rate of decay show that the output of the medium and short ultraviolet from a high-pressure tube with non-activated electrodes diminishes at about three times the rate of a similar tube with activated electrodes; also, the initial output in short ultra violet is lower in the tube with non-activated electrodes.[4]

The inner quartz tube of Fig. 7 is, after thorough degassing and exhausting, filled with a few droplets of mercury and a starting gas such as argon of several mm pressure at room temperature. In the cold state the pressure of the mercury vapor is very low (about 10^{-3} mm Hg at 20 deg. C). After a discharge has been started by the application of a sufficiently high voltage to the electrodes

(Continued on page 138)

Measuring Coil Characteristics

Use of the cathode-ray oscilloscope to measure inductance, Q, impedance, power factor, effective resistance of coils—especially useful when changes are being made in the coils under measurement. Method would also make useful demonstration set-up for technical schools

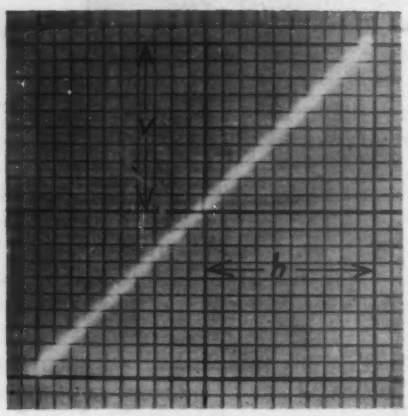


FIG. 1—Proper adjustment of horizontal and vertical gain controls on the oscilloscope will produce equal deflections, with the resultant straight line inclined at an angle of 45 degrees

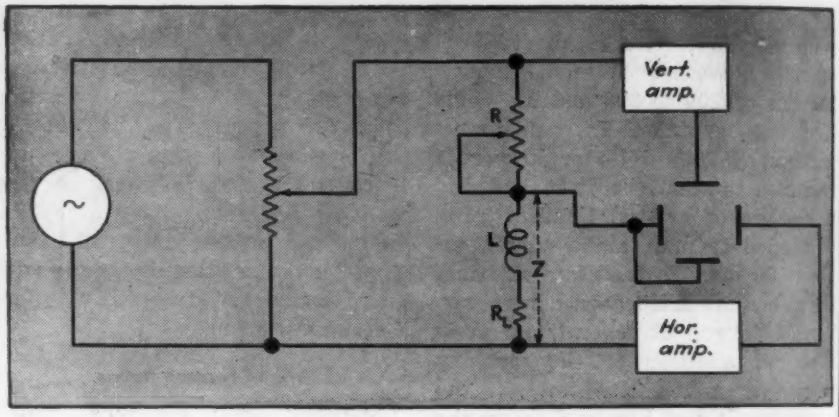


FIG. 2—Circuit in which impedance of the coil L is determined. At proper value of R, the 45-deg deflection will be secured. Then $R=Z$

MANY occasions arise where it is desired to measure inductance, impedance, or other characteristics of coils but a conventional impedance bridge is not immediately available. A cathode-ray oscilloscope may be employed as the indicating device in conjunction with simple, readily obtainable circuit components to accurately perform all the functions of conventional bridges. The basic idea involves connection of the oscilloscope so that the pattern on the screen graphically compares the voltage across the unknown impedance in phase and amplitude to that across a non-inductive resistance. When two sine voltages are simultaneously applied, one to the horizontal and one to the vertical deflection plates of an oscilloscope, the spot motion developed is a mechanical resultant of the two driving forces and is termed a Lissajous figure. (See any text on sound or physics). Two measuring techniques employing these figures will be discussed.

Calibrating the Horizontal and Vertical Amplifiers

The methods to be described require an equal deflection sensitivity for the vertical and horizontal amplifiers in the oscilloscope. To make this calibration, the horizontal and vertical deflection input terminals should temporarily be connected together and a deflecting voltage of any convenient value applied between these terminals and ground. The horizontal and vertical amplifier gain controls are then adjusted so that the pattern appears as Fig. 1, that is, a straight line inclined at an angle of 45 deg. ($v = h$). If a large number of measurements are to be made it is a good idea to seal the gain control knobs in this position with a piece of tape to prevent their inadvertent shift.

Resistance Comparison Method

Impedance. The circuit for direct impedance measurement is given in Fig. 2; R is a variable resistor, L is the coil under test, and R_L represents the total effective resistance of the coil. The alternating voltage supply may be from any convenient source. If an oscillator with output voltage control is available, the potentiometer shown will not be necessary. The pattern on the screen will take the form of an ellipse. The driving voltage should be varied until the horizontal deflection (h) has any convenient value. Resistor R is now adjusted until the vertical deflection is equal to the horizontal ($v = h$ as of Fig. 3). At this position the voltage drop across resistor R is exactly equal to that across the unknown impedance Z, therefore Z is equal to R. If an uncalibrated resistor is used, its resistance at this adjustment may be measured on an ohmmeter. A calibrated resistance will of course give the value directly in ohms of impedance Z. The voltage across R, (E_R) lags E_z by an angle, θ, dependent upon the power factor of Z.

Power Factor. The Lissajous figure may be solved to yield the power factor and other characteristics of Z. At unity power factor θ is zero and the pattern becomes the straight

Without an Impedance Bridge

By H. D. Brailsford, *Underwriters' Laboratories, Inc.*

line of Fig. 1. At zero power factor θ is 90 deg. and the pattern becomes a circle. In Fig. 4 is shown the change in appearance of the pattern due to increased power factor by the addition of a series resistance in the coil circuit. The general equation[1] for this ellipse is

$$v^2x^2 - 2vhxy\cos\theta + h^2y^2 = v^2h^2\sin^2\theta \quad (1)$$

Where x and y are the coordinates of any point, θ is the phase difference in degrees between the two voltages, v and h are the maximum vertical and horizontal spot displacements respectively.

If we choose a point where the ellipse crosses one of the axes, then the other ordinate becomes zero and the equation reduces to

$$\sin\theta = \pm\frac{y}{v} \text{ for a point on the } y \text{ axis.} \quad (2)$$

$$\sin\theta = \pm\frac{x}{h} \text{ for a point on the } x \text{ axis.} \quad (3)$$

Referring to Fig. 4; if $v = 10$, $y = 7$.

Therefore:

$$\sin\theta = 0.7$$
$$\theta = 44° 26'$$

Power Factor of $Z = \cos\theta = 0.714$

A vector diagram constructed to scale as in Fig. 4-A will graphically give the value of inductance and total effective resistance. A more direct method of measuring inductance and effective resistance will be described.

In cases where Z has a very low power factor, that is, θ approaching 90 deg., as in Fig. 3, a considerable error may result due to the inability accurately to locate y. The use of a finer trace will help. A better method, however, is to use a low power factor condenser in place of R in the circuit of Fig. 2. A paper capacitor in the audio range may, for practical engineering purposes, be considered to have zero power factor. The pattern will then be the graphical reciprocal, so to speak, of that attained with the resistance, that is, for zero power factor, θ = 180 deg. and the trace shows a straight line; for unity power factor θ = 90 deg. and a circle appears on the target. Thus;

Power Factor = y/v

For the coil shown in Fig. 3 the power factor determined by this method was found to be 0.2 (θ = 78° 45′).

Resonance Method

Inductance. The circuit employed to determine inductance is given in Fig. 5. A variable oscillator will be required of appropriate frequency range. The coil to be measured is connected in series with a paper or mica capacitor of known value. Resistor R is adjusted to give a convenient vertical deflection. The oscillator is started at its lowest

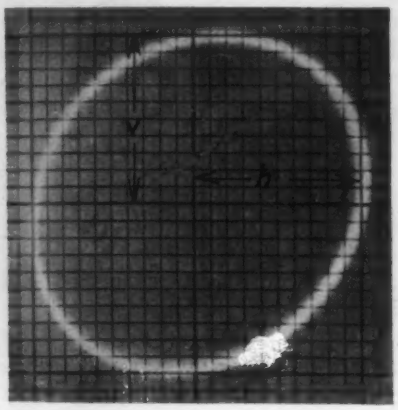


FIG. 3—Oscillogram when the coil has a low power factor. Fine trace will aid in making the measurement; a better plan is to use a condenser of low power factor in place of R in Fig. 2

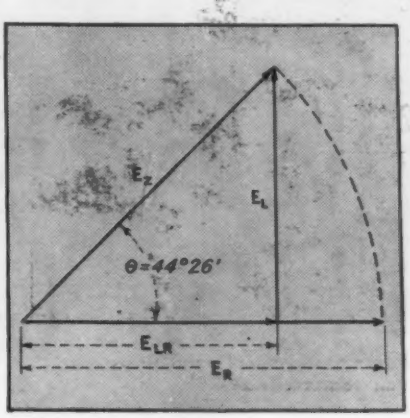


FIG. 4-A—Vector diagram of the situation occurring in Fig. 4

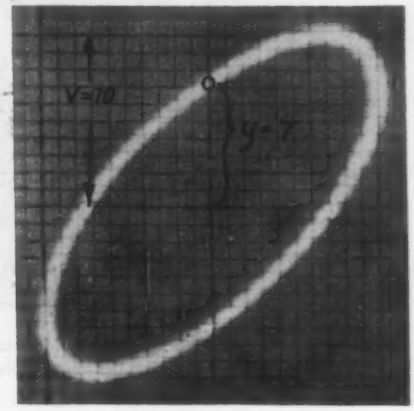
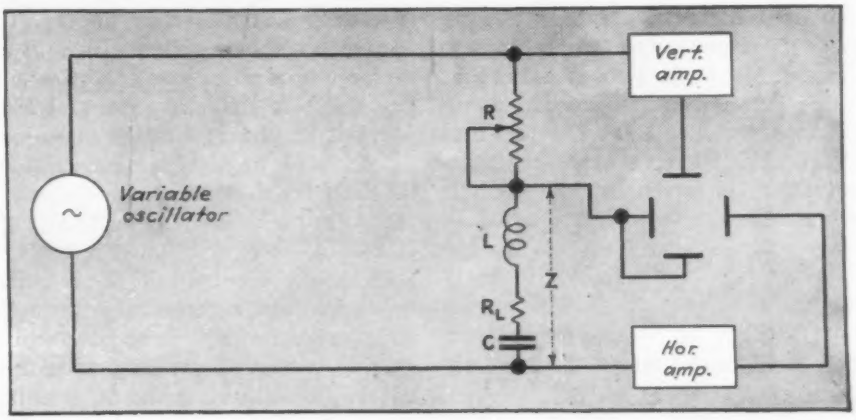


FIG. 4—Appearance of trace when the coil has appreciable resistance

FIG. 5—Resonance methods of measuring inductance of a coil



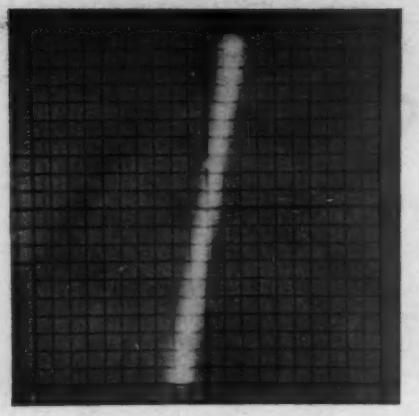


FIG. 6—Using the circuit of Fig. 5, applied frequency is increased until this pattern appears. This will indicate the fundamental resonant frequency of the coil

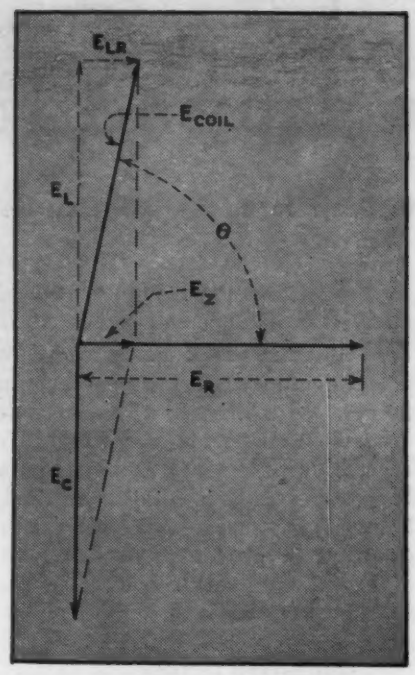


FIG. 6-A—Vector diagram for the condition of Fig. 6

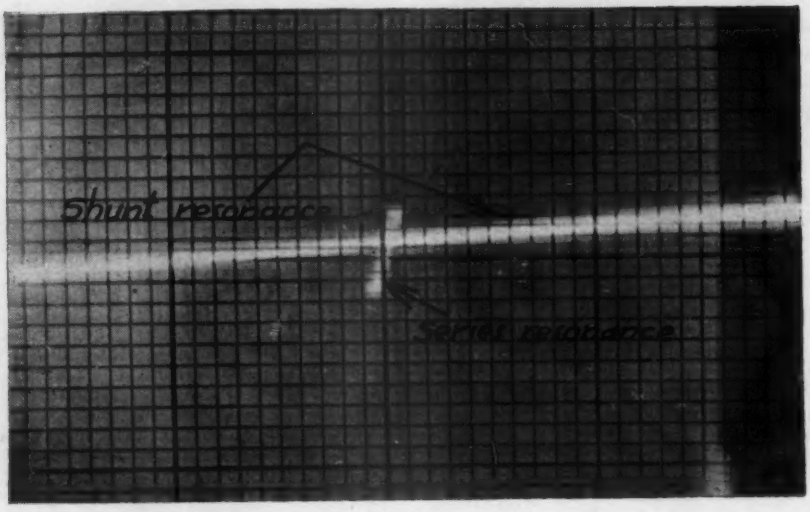


FIG. 7—Composite diagram showing comparison of series and parallel resonant methods of measuring coil characteristics

frequency and gradually advanced until the Lissajous ellipse closes into a straight line as in Fig. 6 denoting zero phase shift between E_R and E_Z. This will be the fundamental resonant frequency of the *LC* circuit. The apparent inductance *L* may readily be determined by reference to any standard impedance chart and is that value of inductance having a reactance equal to *C* at the resonant frequency. A more accurate determination is given by the simple equation

$$L = \frac{\left(\frac{5033}{f}\right)^2}{C} \qquad (4)$$

Where *f* is the resonant frequency, *L* is in millihenries and *C* is in microfarads.

It should be noted that at the balance position shown in Fig. 6, the horizontal deflection is at a minimum. This is so because at resonant frequency the reactance of a series resonant circuit is zero and the voltage drop (E_Z) is solely due to effective resistance. Figure 6-A is a vector diagram for the condition of Fig. 6; E_C and E_L are equal and 180 deg. out of phase; θ is the phase or power factor angle of the coil; E_{LR} is the drop due to effective resistance of the coil and is seen to be identical to E_Z.

It should be noted that the magnitude of E_L and E_C may vary through wide extremes with respect to the driving voltage, depending upon the effective resistance in the *LC* circuit.

Effective Resistance. Referring to Fig. 6, the amount of horizontal deflection *h*, as stated, is due to the voltage drop across the effective resistance of the coil at resonant frequency. (Condenser losses may be neglected throughout the audio and lower radio frequency range.) To measure this directly it is only necessary to readjust *R* until the vertical deflection again equals the horizontal deflection, at which position *R* is equal to the effective resistance of *L* at the frequency at which the measurement is made. For coils having a fairly high *Q*, the effective resistance may be quite small and to get a reasonably accurate measurement the output voltage of the oscillator should be increased to expand the pattern.

Inductance Measurement by Parallel Resonance. Where the inductances under investigation have a very high *Q*, the exact resonant frequency may more easily be determined by connecting capacitor *C* in parallel with the inductance. The operating technique is the same, the difference being that at resonance the voltage across the *LC* circuit is at a maximum and the cathode trace is substantially more sensitive to frequency shift, thus making it easier to set the oscillator at the exact resonant frequency.

When using the shunt resonance method it should be borne in mind that the distributed capacitance of the coil will be, in effect, added to that of the tuning condenser and the indicated inductance will be higher than the true value. For this reason coils having a high distributed capacitance should preferably be measured by series resonance. The coil of Fig. 3, for example, which was a 4000-turn layer wound solenoid, measured 150 millihenries by series resonance and 155 millihenries by shunt resonance. The tuning capacitance was 1.0 microfarad and the resonant frequencies 410 and 404 cycles respectively.

Determination of Q. Having established inductance and effective resistance of a coil by the foregoing methods, the figure of merit or *Q* is readily determined by the familiar equation:

$$Q = \frac{2\pi fL}{R} \qquad (5)$$

It should be mentioned that the output impedance of the driving os-

(*Continued on page* 176)

Film-Recording Seismograph

Heretofore unknown relations between earthquakes and large dams are being studied with special Benioff electromagnetic seismographs sensitive enough to record the lowest levels of earth unrest. Radio and electronic circuits make possible a high degree of accuracy*

Complete Benioff film recorder unit. It is operated in a dark room since the film is not covered. Above: Benioff records made at Fordham University, of freight train 400 yards away (A) and local earthquake 240 miles away (B)

THE CONSTRUCTION within the last decade of several extremely large dams in western states has brought up two questions for which answers are now being obtained with the aid of electronic apparatus—whether the concentration of millions of tons of masonry and water on a relatively limited area of the earth is the cause of local earthquakes, and whether earthquakes have any adverse effect on the safety of these large dams.

For these and other engineering and scientific reasons, a number of Benioff seismographs developed especially for the purpose at the California Institute of Technology have been set up by the U. S. Bureau of Reclamation in the vicinity of three of the largest dams—Boulder, Grand Coulee and Shasta. The instruments are now being operated by this bureau in cooperation with the U. S. Coast and Geodetic Survey.

How a Seismograph Works

A seismograph is fundamentally an instrument for recording data from which the time and direction of arrival of an earthquake wave and the distance from the disturbance can be determined. It usually also provides a record of the waveform and amplitude of each arriving wave. To secure this data, a seismograph must have three seismometers, each responsive to earth movements in one of three directions at right angles to each other. These seismometers must provide individual traces on which the time at any point can be determined accurately. In practice, the directions used are horizontal N-S, horizontal E-W and vertical.

Seismometers generally employ the pendulum principle. A mass having considerable inertia is supported by a Cardan hinge (a suspension which permits almost frictionless movement in one direction only) in such a manner that the mass is initially stationary during movements of its supports due to earth vibrations or earthquakes. Being critically damped, the mass eventually moves with and amplifies the earth movements. The mass (usually a metal cylinder) is called a pendulum even though it does not normally move, because the *relative* motion between the seismometer pendulum and its supports during an earthquake is

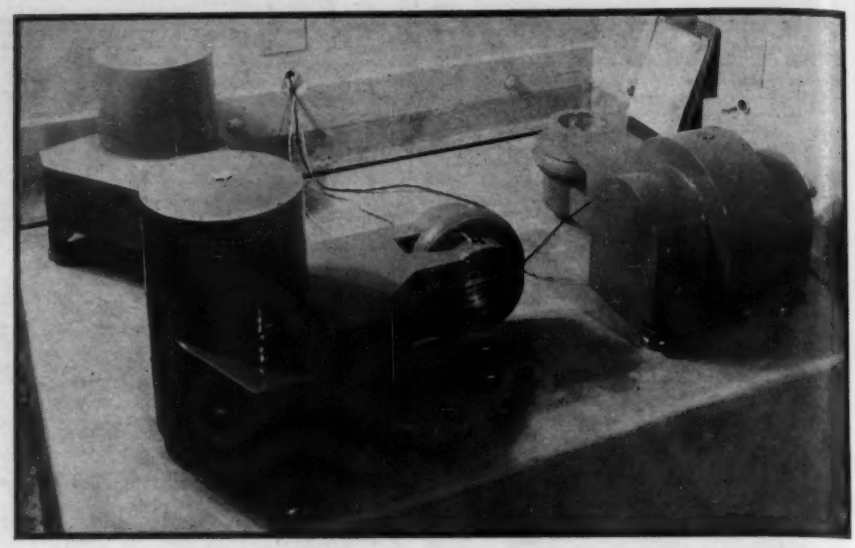
* *This article is based on data supplied by Dr. Hugo Benioff of California Institute of Technology, Dr. D. S. Carder and Associate Engineer Thomas C. Mead of the U. S. Bureau of Reclamation, and Dr. William A. Lynch of the Physics Department of Fordham University.*

much the same as the relative motion of an ordinary clock pendulum with respect to its support.

Coils Used to Measure Motion

A comparative measure of the motion of the earth with respect to a pendulum is obtained in the Bureau of Reclamation seismometers by attaching an extension arm to the pendulum and mounting on the far end of this arm a coil which is positioned in the annular gap of a powerful doughnut-shaped permanent magnet. For purposes of explanation, this permanent magnet can be considered as attached to the pier and therefore moving with the earth, while the coil can be considered as a stationary body of reference. Movement of the earth will then induce in the coil a voltage which is proportional to the magnitude and speed of the movement. This voltage is applied to a recording galvanometer which produces a graphic trace of earth movements.

The pendulums of the three seismometers are positioned essentially as shown in Fig. 1. The hinges for the two horizontal pendulums are vertical like those of a fence gate, and are tilted just enough to keep the pendulums in stable rather than neutral equilibrium. This serves to make the pendulums return to their initial positions promptly after being displaced, just as a gate will close automatically if its supporting post is tilted slightly toward the closed position of the gate. The vertical pendulum is hinged along its length, with the hinges positioned horizontally like those for a trap door in a floor. This pendulum is supported against gravity by a leaf-type spring.



Three seismometers in position on a concrete pier at a station near Grand Coulee dam. They respond respectively to E-W (at left rear), N-S (at left front) and vertical motion of the earth

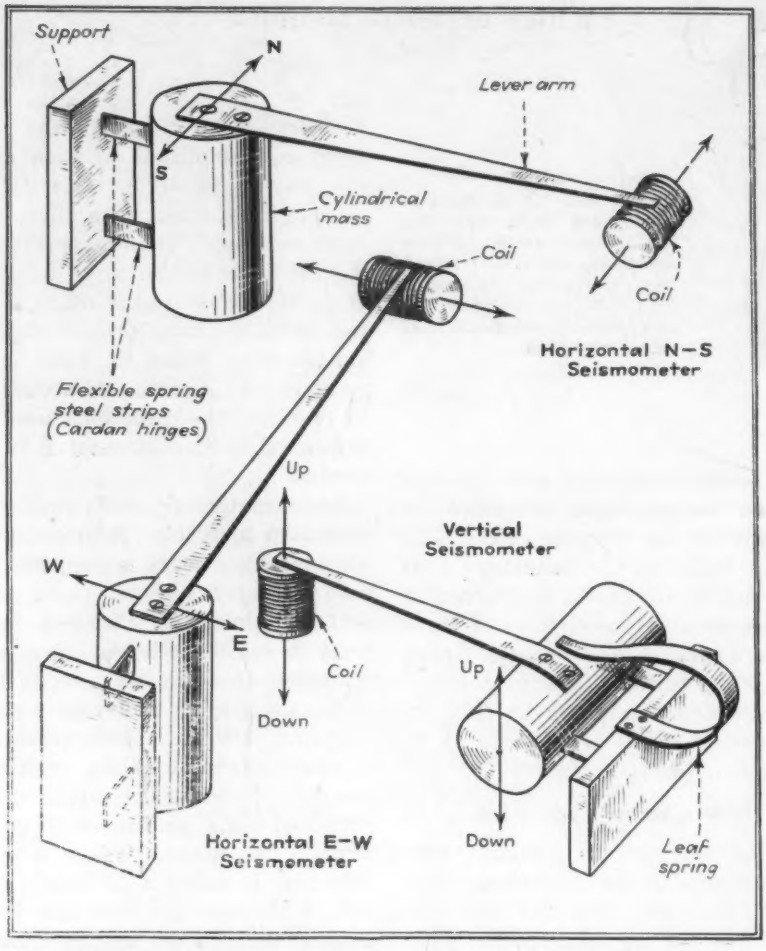


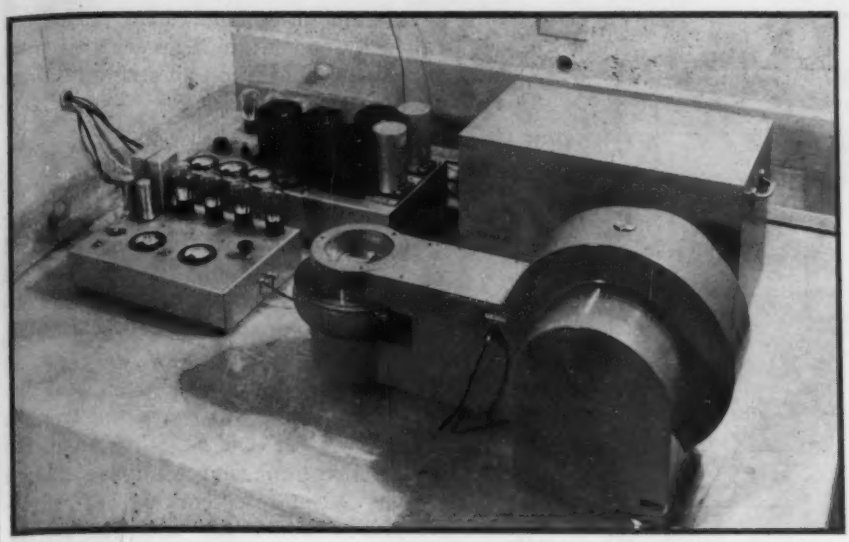
FIG. 1—Simplified diagrams illustrating methods of mounting the pendulums for the three seismometers. The cylindrical masses and attached coils are initially stationary even though the earth moves

It should be pointed out that no means are employed for keeping the pendulums at absolute rest. There is a certain amount of inherent damping in the coil-magnet system, however, because induced current in the coil sets up a magnetic field which interacts with that of the permanent magnet to produce a force which opposes coil movements.

Special pendulum-damping systems are not necessary because earth disturbances set up waves of various types which are readily recognizable on the traces. These waves have different velocities also, and consequently arrive at a given station at different times. Earthquake analysis requires only a graphical record of the relative motion of the mass and the pier plotted against time.

Recording Galvanometer

No amplification is needed between a pickup coil and its recording galvanometer, since the power output of the coil derived solely from earth movements is more than sufficient to record the lowest level of earth unrest. As a matter of fact, the sensitivity obtained with a standard mirror galvanometer is so



The vertical seismometer unit at the right foreground detects earthquakes, and the amplifier-relay unit at its left increases recording lamp intensity for the duration of an earthquake. At the rear is the 10-cycle power supply

great that a potentiometer must be provided between coil and galvanometer to reduce the sensitivity when necessary.

The maximum usable sensitivity at a location is limited by the microseisms or "baby earthquakes" at the location. These constitute the lower level of earth unrest, and are found whenever there is heavy machinery in operation, heavy road traffic, water falling, etc. Recording of microseisms would confuse seismogram interpretation, just as a high level of static noise confuses radio reception. Reducing the sensitivity with a potentiometer relegates the microseisms to the background where they are of no consequence.

Photographic recording is employed. For each seismometer there is a lamp-lens system which projects a narrow pencil-like beam of light on the galvanometer mirror. The resulting reflected beam falls on standard 35-mm movie film wrapped around a drum driven by a constant-speed motor. The light beam traces on the film a curve which after development constitutes a permanent trace of earth movements.

Time-Recording System

The time of arrival of the different wave phases must be determined as accurately as possible because earthquake waves travel at the rate of over a hundred miles a minute. Several factors enter into attainment of satisfactory timing accuracy in this seismograph.

First of all, each half minute an accurately calibrated chronometer produces an electrical impulse which momentarily deflects reflecting mirrors in the paths of all light beams. As a result, small square-cornered notches are produced on the light beam traces of all three seismometer film strips and sometimes also on a fourth film serving exclusively for time-recording purposes.

The chronometer is checked eight times daily against Navy radio time signals broadcast from Mare Island. For five-minute periods at a time these signals are recorded on the time drum by a radio receiver employing the circuit of Fig. 2. This is a t.r.f. circuit permanently tuned to 113 kc, and is operated by an automatic time switch.

The scheme employed for recording the radio time impulses is similar to that used for the half-minute marks, with the receiver output causing deflection of the light beam serving the time drum. No confusion can occur if the half-minute chronometer signals and the radio time signals come simultaneously, because the two deflections are additive and radio time signals will stand out individually wherever they occur on the film.

Radio time signals are usually fed only to the time drum so as not to complicate earthquake recording, but at the Seismological Laboratory in Pasadena both chronometer and radio time signals are recorded on the three seismometer drums, and no time drum is used.

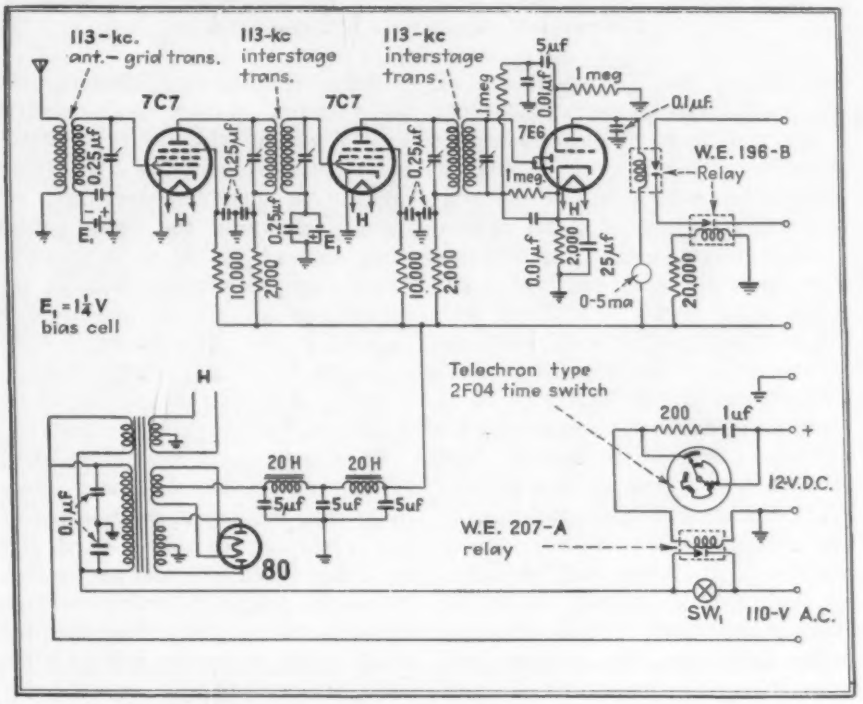


FIG. 2—Circuit used to receive Navy time signals for comparison with similarly recorded chronometer signals in the Benioff film recorder

Film-Driving Motor

To assign accurate times to the arrival of different wave phases, it is essential that all recording drums for a given installation should rotate at the same speed. This requirement is met by mounting all four recording drums (two for horizontal, one

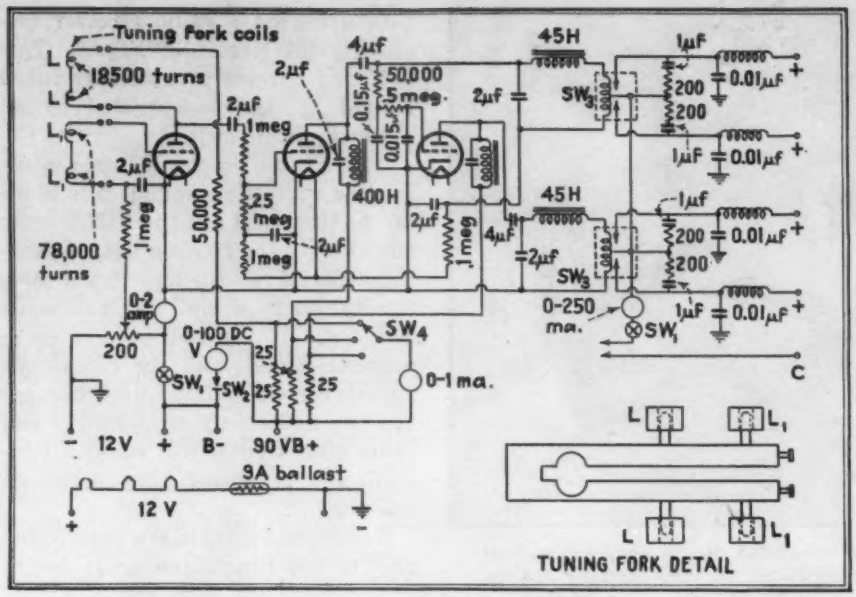


FIG. 3—Relays energized by this tuning fork-controlled electronic amplifier circuit produce 10-cycle impulse power for the film drum motor of the Benioff film recorder. All tubes are W.E. type 247-A

for vertical and a time drum) on one shaft. Galvanometric recording is superior to mechanical recording systems in this respect, in that it imposes few restrictions on the location and arrangement of the drums.

Another requirement for accurate time indications is uniform drum speed. This cannot be attained with the stop-and-go drives of clock escapements, nor is it possible with synchronous motor drives from a commercial power system during inevitable power disturbances. The problem was solved in this seismograph by using storage batteries to produce 10-cycle impulse power which is kept at constant frequency by tuning fork control. A trickle charger operating from commercial power lines keeps the storage batteries charged sufficiently at all times to carry the apparatus over normal commercial power outages without affecting drum speed.

The impulse-generating circuit arrangement is shown in Fig. 3. Cylindrical iron lugs on the arms of the tuning fork project partly into the hollow centers of the coils and thus serve as cores. When tuning fork vibrations cause the lugs to move relative to coils L_1, residual magnetism in the lugs induces a voltage in these two coils. This voltage will act on the grid of the first tube and be amplified, and the resulting plate current at the fork frequency will flow through coils L and keep the fork vibrating.

After further amplification, the plate current is used also to control two Western Electric type 209-A polarized relay switches SW_2. These operate in quarter-phase time sequence, changing the storage battery current to 10-cycle quarter-phase impulse current suitable for operating the ¼-watt synchronous impulse motor. This motor in turn drives the recording drums through a train of gears terminating in an endless metal-belt pulley system.

Each drum has a circumference of 90 cm, and hence will hold about three feet of film. A drum speed of one revolution per hour is used, giving a film speed of ¼ mm per second. The entire drum-supporting carriage translates to the left for the effective width of the film at the rate of 0.035 inch per hour. In this way, the record for an entire 24-hour period can easily be contained as a spiral trace on a single three-foot strip of 35-mm film per drum.

Flasher Circuit for Lamps

The first impulses of a local earthquake are highly important to the seismologist. Unfortunately, the first vibrations reaching the recorder are so rapid and have such great amplitude that a light beam of ordinary intensity would move too fast to register on the photographic film except possibly at peaks and troughs of the wave. On the other hand, the use of a light source intense enough for adequate recording of earthquakes would fog the film during quieter periods. This problem was solved by using an additional vertical seismographic element called the flasher, and connecting it through an amplifier to a relay as shown in Fig. 4. Whenever ground motion exceeds a predetermined value, this relay closes and shorts out resistance in series with the recording lamps, thus increasing the brilliancy of the light beams. Each strong earth shock "flashes" the lamps for a few seconds. The lights are thus kept bright for as long as an earthquake continues to jar the flasher unit, plus an additional few seconds.

As yet it is too early to draw conclusions regarding relations between dams and earthquakes, but valuable data is being acquired. After recordings have been made for several more years, it is hoped that it will be possible to solve the mystery of the local earthquakes which started the entire investigation—those picked up at the Tucson station from the direction of Boulder Dam.—J. M.

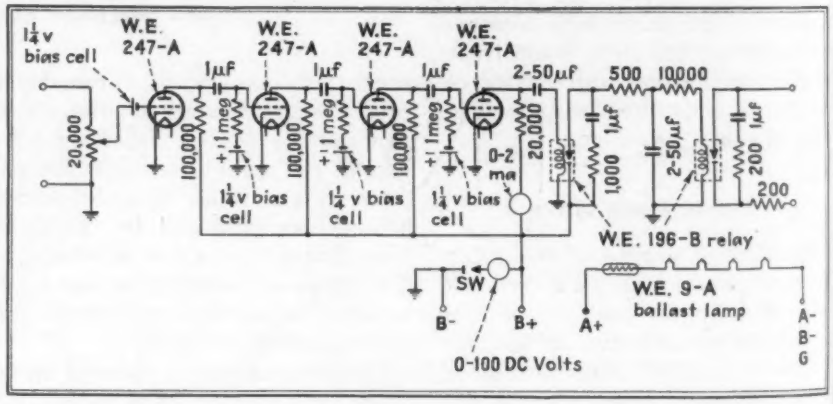


FIG. 4—Light intensifier or flasher circuit used between the earthquake-detecting vertical seismometer and the galvanometer lamps to increase recording beam intensity during earthquakes

The Emissive Power Of Typical Grid and Plate Surfaces

By RAYMOND SZYMANOWITZ

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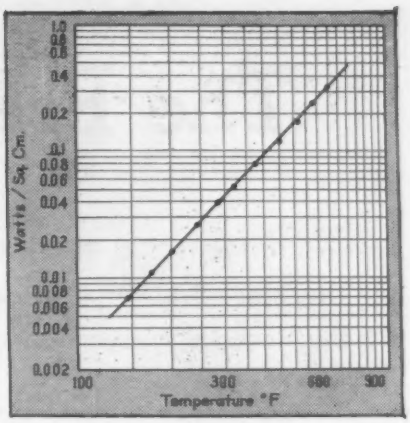

Emissive power as a function of temperature of nickel plated steel with matte graphite coating

IT is customary in the manufacture of radio receiving and transmitting tubes, where heat dissipation is important, to roughen and/or carbonize the grids and plates, thereby minimizing undesired thermionic emissions.

Roughening of these tube parts may be achieved by acid etching or sand blasting, while carbonizing may be carried out by one of several methods. Batch carbonizing, for example, is accomplished by heating the tube members, prior to assembly, in an atmosphere of methane. By closely controlling this operation so that the methane undergoes incomplete combustion, very black, adsorbed films of carbon are produced. A continuous process known as strip carbonizing consists of applying concentrated suspensions of graphite or carbon black to the prefabricated metal in ribbon form and subsequently baking the same.

Method of Making Measurements

To circumvent the difficulties which attend both of these processes, it has become common practice during recent years to heat mildly the tube parts at the time of assembly and spray them with an aqueous dispersion of colloidal graphite known commercially as aquadag. When graphite coatings produced by this method are applied to roughened surfaces, their emissive power, while not so high as that of carbon black, is adequate for a large variety of tubes.[1]

To determine the radiation properties of the various grid and plate surfaces employed in vacuum tubes, sheets of nickel and nickel plated cold rolled steel were subjected to such treatments as acid etching, sand blasting, acid etching and graphiting, acid etching and carbonizing, sand blasting and graphiting, sand blasting and carbonizing, oxidation, oxidation and graphiting, oxidation and carbonizing, etc. The emissive power of these test pieces was measured with a calibrated thermo-

(*Continued on page* 178)

[1] Representative tube types in which graphite hydrosol is used on grids or plates to increase radiation or reduce secondary-electron emission are: (for receiving) power amplifier triode, triple grid power amplifier, beam power amplifier, pentagrid converter, pentagrid mixer amplifier and rectifier-doublers; (for transmitting) power amplifier pentode, r-f power amplifier pentode, beam power amplifier and screen grid r-f power amplifier.

EMISSIVE POWER OF SPECIMENS IN TERMS OF WATTS PER SQ. CM.
(By Interpolation)

	Temperature Deg. F.									
	150	200	250	300	350	400	450	500	550	600
Plain nickel	.003	.005	.007	.010	.014	.018	.022	.027	.033	.038
Plain N.P.C.R.S.*	.003	.006	.010	.015	.022	.029	.038	.048	.058	.071
N.P.C.R.S. acid etched	.003	.007	.012	.018	.026	.034	.046	.059	.073	.089
N.P.C.R.S. sand blasted	.007	.013	.022	.033	.047	.064	.082	.105	.130	.160
Oxidized nickel	.004	.010	.018	.031	.047	.068	.094	.125	.162	.208
Nickel with polished graphite coating	.008	.016	.028	.044	.066	.090	.121	.159	.200	.245
N.P.C.R.S. with matte graphite coating	.007	.016	.028	.044	.066	.093	.125	.165	.210	.260
Oxidized nickel graphite coated	.008	.017	.031	.048	.072	.097	.130	.170	.215	.265
Nickel with matte graphite coating	.009	.019	.033	.051	.075	.102	.135	.176	.220	.270
N.P.C.R.S. with polished graphite coating	.009	.018	.032	.049	.073	.100	.132	.172	.218	.270
N.P.C.R.S. acid etched and graphite coated	.012	.023	.039	.053	.081	.110	.143	.183	.223	.275
N.P.C.R.S. sand blasted and graphite coated	.009	.019	.033	.050	.076	.104	.139	.184	.228	.282
N.P.C.R.S. acid etched and strip carbonized	.008	.018	.032	.051	.078	.108	.145	.194	.245	.310
Oxidized nickel batch carbonized	.013	.027	.049	.076	.114	.156	.210	.275	.346	.430
N.P.C.R.S. sand blasted and strip carbonized	.015	.031	.054	.083	.122	.166	.220	.286	.360	.445

* *Nickel plated cold rolled steel.*

The Precision Tuning Problem

Between 60 and 200 Mc there are 1000 channels if allocations are on a 0.1 percent basis; but there are 14,000 if allocations are on a 10-kc basis. Means are suggested for securing the necessary precision of tuning to use these channels

THE technical advances of the last war led directly to broadcasting in the present 1000-kc band.

The technical advances of this war foreshadow a post-war radio art greatly freed of its limitations as to the number of channels of communication available by proper utilization of the great new world of UHF. The key to unlock these possibilities is precision of frequency to a degree hitherto unattained; and the responsibility of forging this key belongs to the radio engineer.

Very probably the first excursion into UHF will be in the region of 60 to 200 Mc, a band 140,000 kc wide. If allocations are on a 0.1 percent basis there will be slightly over 1000 channels available, but with our old familiar 10-kc channel allocation there are 14,000 channels available.

These extra 13,000 channels are a prize well worth striving for. They bring that day closer when every man can have his own transmitter as well as receiver.

This band of frequencies is quite attractive when compared with 3000 Mc for instance, as the antennas are of reasonable size, giving good pick-up, and reflection and absorption phenomena are less pronounced. We have some instrumentation available, also, and more or less standard tubes are operative in this region.

A concrete problem in precision setting of a tunable receiver would be a university broadcasting say 50 classes on 50 transmitters. If we spaced them 20 kc apart we would have 50 channels to the megacycle, and if they were side by side, we would cover say from 150,000 kc to 151,000 kc. The transmitter would be within 1 kc of assigned frequency, as allowed by present crystal practice.

The problem of manufacturing a receiver capable of picking out the desired channel in such a case can be attacked in two ways—by accuracy and by scanning. Discussion of the possibility of obtaining accuracies of this order must be left until after the war, but are none too bright.

Virtues of Scanning-type Receivers

The scanning receiver is quite old—in 1908 a patent shows a motor driven tuner which stops when a signal is received. The modern variation on this old idea would use a superheterodyne with a control tube on the oscillator, and some means of rather slowly varying the bias on the control tube, such as a one-cycle multivibrator, so the receiver would be swept through the desired band. Since the receiver would pass through all possible frequencies in this band, at some instant it will exactly tune in the carrier.

At the output end of the intermediate frequency amplifier would be a "director" unit, for instance the usual FM detector unit with balanced diodes giving positive voltage on one side of resonance and negative voltage on the other side. A usual receiver acceptance band width of 10 kc can well be used.

As the carrier is passed through, the director would develop appropriate voltage to hold the receiver on the carrier. Experience has shown the carrier can be intercepted and locked on at such low values of input level that the signal is well below the noise level of the first circuit and tube, and we can expect the receiver to be

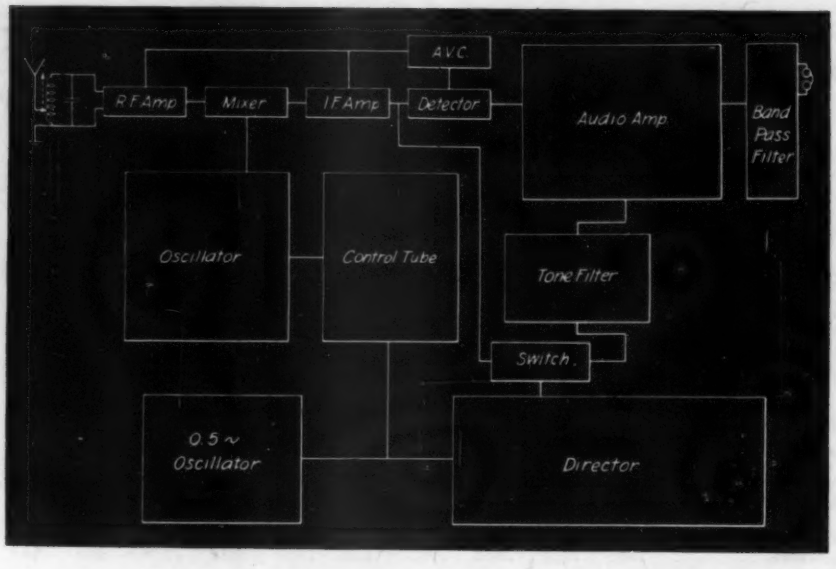

FIG. 1—Block diagram of the proposed system. To an ordinary superhet are added a multivibrator sweep circuit to scan the band to be used, and a director to lock the receiver on the desired carrier

in U-H-F Broadcasting

By S. YOUNG WHITE

LIST OF TUBES AND VALUES

Function	Tube Type	Grid Leak	Plate Resistor
Oscillator	955	25,000	10,000
0.5 cycle Osc.	6N7	2 megs	0.2 meg
Control Tube	954	0.5 meg	.....
First Audio	6N7	0.5 meg	0.25 meg
Output	6R7	0.5 meg	.....
Filter Amp.	6N7	0.5 meg	0.15 meg
Filter Rect.	6R7 diode	0.1 meg	
Director Driver	6K7	0.5 meg	screen 20,000
Director Diode	6H6	0.5 meg	

held to closer than 1 kc of the carrier frequency.

This system works very well in practice, but does us little good where a number of adjacent carriers is involved, as the receiver will seize on the first one encountered. Our scanning receiver must be made to sweep over a band wide enough to include many inaccuracies in the receiver—warm up drift, voltage, temperature and humidity effects, dial and setting inaccuracy—to name the most important. Consequently we must choose a sweep ten or twenty channels wide, and must identify the desired carrier in some way.

Scanning receivers of the motor-driven type have been suggested which stop on each carrier consecutively and remain in this condition until a complete series of dots which identify a particular carrier has been received. If this carrier is unwanted, the receiver resumes the scanning condition until it encounters a carrier having the predetermined number of dots which distinguish the desired carrier. Having located such a carrier, the receiver remains receptive to the carrier until either the receiver or the carrier is turned off.

How to Identify the Desired Carrier

It is easily realized that this is a time-consuming process, and, when a large number of channels must be explored, a transmitter must be transmitting its identifying code for a very considerable time to insure that the receiver has had time to locate it. We avoid this delay by identifying the signal with a "tone" and providing means whereby the receiver locks on a carrier having a predetermined "tone."

This "tone" can be of sub-audio, audio or super-audio frequency. The sub-audio range is rather unattractive due to the long time interval required for one cycle and for filter voltage build-up, as well as the size and weight of the filter. The tone may well be in the audio range, but if it is desired that the tone be on all the time, some complication ensues from the necessity of putting a "hole" in the audio response curve so that the tone would not be heard sufficiently loudly to interfere with the speech transmission.

Receivers of the broadcast type often have a cut-off of 4000 cycles as the upper limit of the audio band received. The identifying tone frequencies may, therefore, commence at 5000 cycles, for example, and continue on up indefinitely, say to 20,000 cycles or even higher.

The advantage of having the tone on all the time is especially marked in mobile work, where due to interference patterns on the ground or the acrobatics of a plane in the air, there may be short intervals where zero signal exists in the receiver antenna. After this condition ceases to exist, however, rapid and positive contact with the carrier must once more be obtained, and naturally, if the tone were not there, the receiver would not lock on the carrier.

The way to utilize this tone is to provide a receiver of the type aforementioned but in which the director device which serves to effect the locking on the carrier is normally inoperative, and is only rendered operative to perform the locking function by a switching device which responds to the identifying tone impressed on the desired carrier.

It will be realized that once a receiver is designed to respond only to an identifying tone, it must not respond to a carrier it passes over, regardless of its strength, which does not have the exact tone identification for which the receiver has been designed. A feature to be guarded against in the construction of a receiver which rapidly scans a large number of channels is the building up of paralyzing transients which will, in effect, cast a shadow behind such a strong undesired carrier that the receiver will keep on sweeping, but will be paralyzed until the excess voltage charges leak off, as for example from the grid circuits. This means that the desired station may be hidden in such a shadow so that the receiver will lack the necessary sensitivity to pick it up promptly when sweeping in one direction, but when returning in the sweep from the opposite direction will pick it up.

In high speed scanning receivers of the tone identified type the action of the AVC device should be either extremely fast or extremely slow. If it has some intermediate value, it will cause the receiver to lose sensitivity for a time just after passing over an undesired carrier. Since the receiver continues scanning regardless of the AVC voltage developed, there would be a certain time of

AVC voltage decay during which the receiver will be quite insensitive, and unable to pick up a weak desired carrier which may be encountered. In scanning at the rate of several hundred channels per second, a high speed AVC action is rather difficult to secure. An extremely slow one is preferred which will build up only a negligible voltage in passing through an undesired carrier at these high scanning speeds, attained by choosing large values for the AVC filter.

Requirements of the tone operated switching device or "tone switch", are severe. We may sweep at the rate of 100 to 200 channels per second, equivalent to passing over the entire broadcast band in considerable less than one second. Differently expressed, it means passing through a desired carrier in substantially 5 to 10 milliseconds. In that time the tone switch must build up to full amplitude of action, must charge up its filter condensers, and must energize the director, which in turn must build up and charge its filter condensers, and the signal must be locked on and held. This requires that no transient surges can be allowed to build up, no matter how small, which, on discharge, would tend to cause release of the carrier once it had been identified and locked on.

The tone can be recognized and utilized by mechanical resonant systems, as for example, by a tuning fork; or by a resonant electrical circuit or several such circuits in cascade. The selectivity must be of such a high order that, if the circuit is tuned, for example, to accept 7000 cycles, no response whatsoever can be tolerated at 6500 or 7500 cycles. It will be realized that the desired signal modulated at 7000 cycles may generate a voltage of one microvolt but an undesired signal modulated at 6500 cycles may generate a voltage of 100,000 microvolts and the receiver must not lock or even hesitate when passing through the 100,000 microvolt undesired signal. The customary manner of securing this selectivity is to use as highly resonant circuits as practical and cascade them until the desired degree of selectivity is attained. The size and weight of such a filter is considerable, and it has the further serious objection that the time interval required for full resonant voltage to build up is too long to permit the receiver to scan at a sufficient rate.

Having considered some aspects of the problem, the block diagram of Fig. 1 shows an actual receiver that meets the requirements. It is inductance tuned from 100 to 200 Mc. Actually it was a double superheterodyne (not shown as such) with 17-Mc first i.f. and a 460-kc second i.f., with headphone output so we could check it as a mobile unit. All image and spurious responses were 90 db down. With a two-stage r-f amplifier, the output at twice the noise voltage was secured at one quarter microvolt in the 72-ohm line input. Bandwidth is 15 kc with sharp cut off and sweep range of 1 percent. This wide sweep was chosen to get experience, as there is no necessity for all of the sweep in the problem we have set up in this article. In all ways the receiver was designed for maximum possible performance to fully survey the capabilities of the system, and of course, had features not feasible to incorporate in a commercial receiver. A much simpler receiver would do quite as well for this purpose.

The oscillator and control tube were the subject of a very considerable research program.

How to Achieve Selectivity

Experience has shown that the cathode of the oscillator tube must be grounded to eliminate heater-to-cathode cyclic effects, when the source of heater voltage is alternating current or direct current from the battery which also supplies a motor generator or vibrator type of plate supply voltage. At these high frequencies the grid of the tube has extremely poor admittance effects, and if attempts are made to tune the grid circuit, conditions almost invariably occur where the system will commence oscillating at a parasitic frequency determined by the constants of the plate cricuit. It is, therefore, preferred to use an oscillator whose plate circuit is tuned, with a tickler circuit to provide a grid voltage of the proper phase to generate the oscillations. The resonant plate circuit may have lumped constants comprising the coil and condenser as shown, or may comprise a quarter-wave line. Where the constants of the circuit are lumped, a variable condenser is unsuitable for tuning due to the varying L/C ratio, which gives much more stability at one end of the tuning range than at the other, thereby providing greatly exaggerated variations of the range of sweep of the control tube. By making the tuning condenser of a fixed value and varying the inductance coil so as to change its permeability, as by means of a powdered magnetic core, substantially equal percentage tuning effects are secured throughout the band of frequencies. An additional advantage of effecting the tuning of the oscillator by change of permeability lies in a more simplified switching procedure where different coils are used for the reception of different frequency ranges. Each such coil may have attached to it permanently its own tuning condenser, thus forming a circulating path of low resistance, and the only switching required is for the switching connections at the grids and plates of the tubes.

The conventional control tube cannot be used with this oscillator without some modification. A control tube network always includes some means of taking voltage from the tuned circuit, shifting its phase as near to 90 deg. as practicable, amplifying it with the control tube, and introducing the resultant back into the tuned circuit. Being 90 deg. out of phase, it thus acts as a reactance, either inductive or capacitive, and thus retunes the circuit to some new frequency. By controlling the amplifying ability of the control tube, we can introduce any desired fraction of this reactance and thus tune smoothly over a small band by varying the grid voltage of the control tube.

Phase-Shifting Problems

The simplest phase shifting network is to insert a series resistance in the grid circuit of the control tube. To produce 90 deg. of shift, however, the resistance would have to be infinite, and the condenser perfect. Since the condenser is the input capacity of the tube, and at these high frequencies has a large loss component, we cannot meet this requirement. The series resistance cannot be very large either, or it would cut down the voltage across the condenser (the input capacity of the tube) to a negligible value. Since the amplifying ability of tubes at these frequencies is very low, we must start with a high value of input to obtain a reasonable output.

We overcome this difficulty by introducing another phasing network to make up the difference between the 80 deg. or so of phasing we can obtain in practice with the simple network, and the desired 90 deg.

The grid tickler of the oscillator is shown in the diagram as consisting of two inductances. One is the mutual inductance with the tank circuit, the other the leakage inductance of the tickler itself. There is of course a phase shift in the charging current of the oscillator grid as it passes through the leakage inductance, and by proper design of the tickler we can vary this between rather wide limits. By taking off the excitation for our control tube network from the oscillator grid we have a voltage which is already phased somewhat, and the resistance of 700 ohms in series with the control tube grid completes the phasing to as close to 90 deg. as we require. In practice we can even exceed 90 deg. if we wish.

This is important, since if the control tube reflects positive resistance it may stop the oscillator, and if it reflects negative resistance the combination may parasitically oscillate at the frequency of some loop in the system.

The cathode of the control tube is six volts above ground and held there by a small bleeder. The useful range of control voltage is from -3 to -9 volts or ± 3 volts centered about the fixed bias.

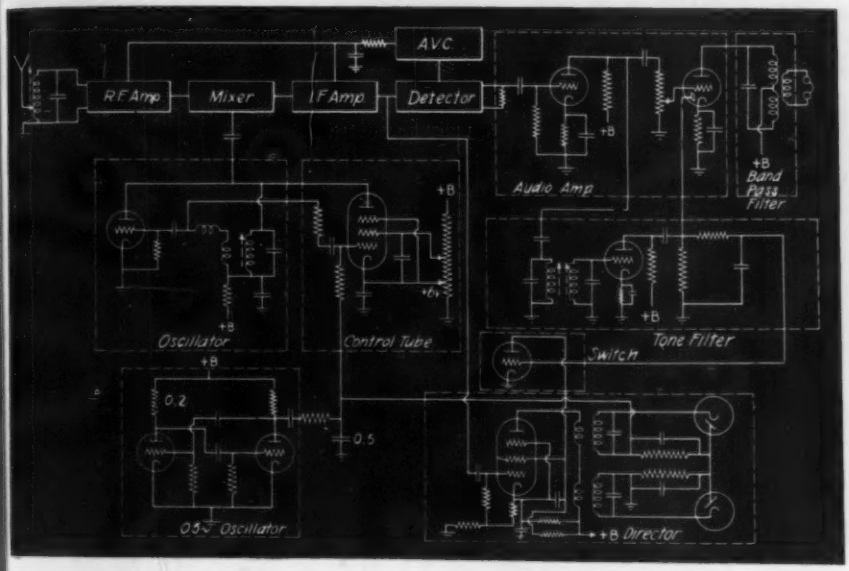

FIG. 2—Circuits employed in the scanning-type precision-tuned receiver for u-h-f use. Although values of the components will vary with frequencies employed, etc., considerable data will be found in the text

Multivibrator-Director Circuits

The 0.5 cycle sweep oscillator shown is a multivibrator with grid condensers of one-half microfarad and grid resistors of two megohms. It generates about 100 volts of the usual bad waveform. This is taken off a 10-megohm resistor which feeds into the $\frac{1}{2}$ μf condenser at the bottom of the control tube grid leak, and generates about ± 3 volts across it which, because of the marked filter effect of the 10 megohms, is nearly sine wave. It will be noted this voltage is left on continuously, as it takes about 10 seconds to start up. When the director is in action it can deliver ± 25 volts which is sufficient to swamp the ± 3 volts of the sweep oscillator.

The director is the one described in the writer's article on Signal Seeking Systems in the January 1935 issue of ELECTRONICS. It has the advantage over later devices of the same type in that the low impedance primary windings give very good limiting action—with one-quarter microvolt into the antenna transmission line we observed ± 22 volts out, and with 100,000 microvolts in it gave ± 26 volts out. This obviously minimizes transients as we sweep through a strong signal.

The cathode of the director driver tube is 50 volts above ground. The screen is in parallel with the switch tube, a triode. When the switch tube has no bias (the no-signal condition) it draws relatively heavy current through their common series resistor and holds the screen at $+20$ volts. Since the cathode is $+50$ volts, the screen is thus -30 volts, and the driver tube is absolutely blocked. By impressing -10 volts on the grid of the triode switch tube, it is blocked, draws no current, and the screen rises to 150 volts above ground, or 100 volts above the cathode and the driver tube is fully operative. It is the purpose of the tone filter assembly to furnish this -10 volts when a signal having, in this case, 7000 cycle modulation, is passed over.

The tone filter must meet two opposing requirements—almost infinite selectivity and also very rapid response. We can tolerate no response to a 100,000 microvolt signal modulated at 6500 or 7500 cycles, and yet we must fully respond in a few milliseconds to 7000 cycles carried by the weakest usable signal of less than one microvolt.

The two coupled tuned circuits shown in the tone filter have a Q of 25. This is the highest Q that will allow full amplitude to build up in 3 milli-seconds. These are fed through a small capacitor from the plate of the first audio tube. Their output is stepped up by a resistance coupled stage and impressed on the diode shown as being in the final audio tube. There it is rectified, and the negative voltage produced blocks the switch tube. But how about the off-frequency response? Since our Q is 25 and cannot be more except by increasing build-up time, the 6500 cycle response is down about 3 times, and we must drive this down to nothing.

Use of Limiter Action to Increase Selectivity

Off resonance, a tuned circuit requires considerable power to give an appreciable response. Our first design point is to arrange the first audio tube to have quite small plate current, so the maximum power it can deliver to the tuned circuits is sharply limited, and strong off-frequency response is prevented.

The second design point is to work into a backed-off diode—one that will not respond at all unless a certain threshold value is exceeded. In this receiver the bias on the last

(*Continued on page* 214)

Electronic Control of D-C Motors

Electronic motor control provides variation over wide range of speeds. Substitution of electronic control for motor-generator drive aids war effort by releasing rotating machinery for additional productive uses. Comprehensive treatment of electronic methods of motor control

By E. E. MOYER,

Electronic Section
Industrial Control Engineering Department
General Electric Co., Schenectady, N. Y.

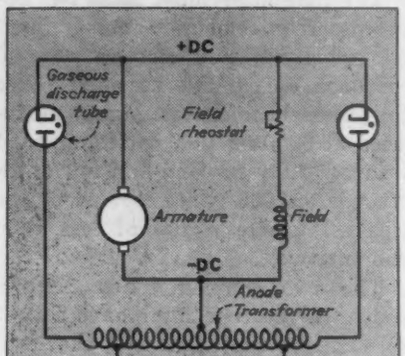

FIG. 1—Simplified functional diagram illustrating application of electronic rectifiers to control of a d-c shunt motor

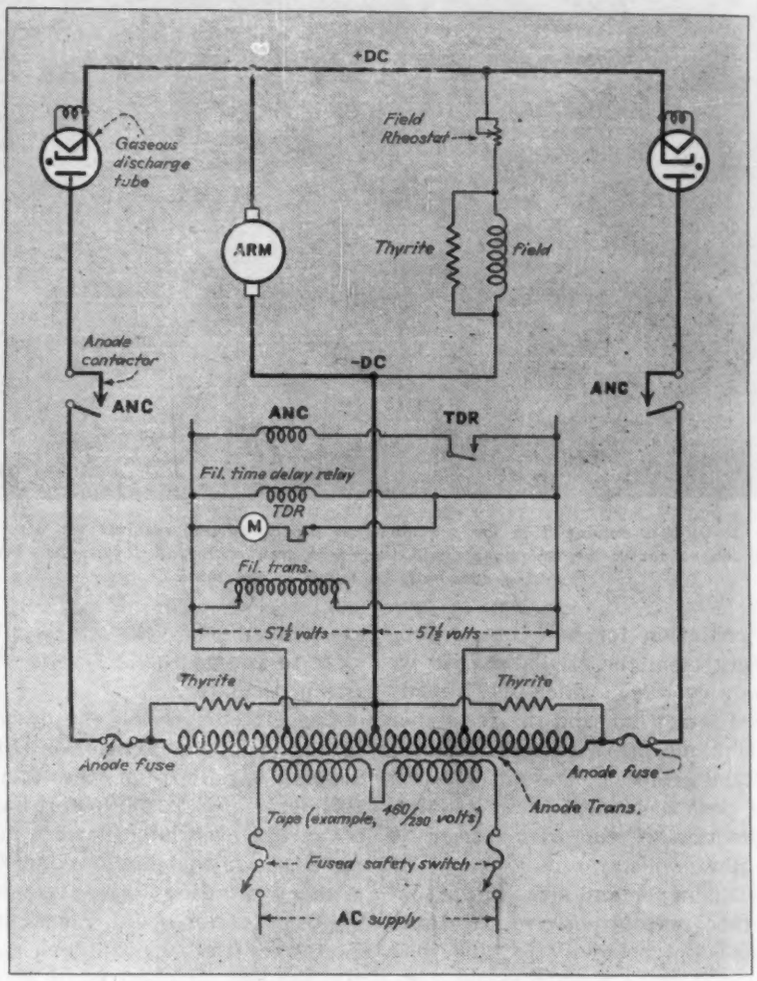

FIG. 2—Complete engineering diagram of rectifier and auxiliaries for supplying power to a d-c shunt motor

DIRECT-CURRENT motors are based on the electrodynamic principle that a conductor through which current flows, and which is exposed to a magnetic flux, is subjected to a deflecting force. If such secondary influences as saturation, and armature reaction, are disregarded, the basic performance characteristics of d-c motors can be explained by the following simplified relations:

1. Torque is proportional to the product of armature current and field current.
2. Counter emf is proportional to the product of speed and field current.
3. Counter emf is equal to line voltage minus IR drop.

Continuous capacity is governed primarily by heating limitations. In the case of duty cycles, the rms value of motor horsepower has to be calculated for a complete operating cycle to determine the equivalent continuous rating. Overload capacity is determined by the maximum torque the motor is able to deliver and by the commutation limit.

Most frequently d-c motors are used because of their variable speed characteristics, and the use of a d-c motor implies a d-c power supply. In industries or locations where d-c power is available the d-c motor is readily applied, particularly where

s . . . Part I

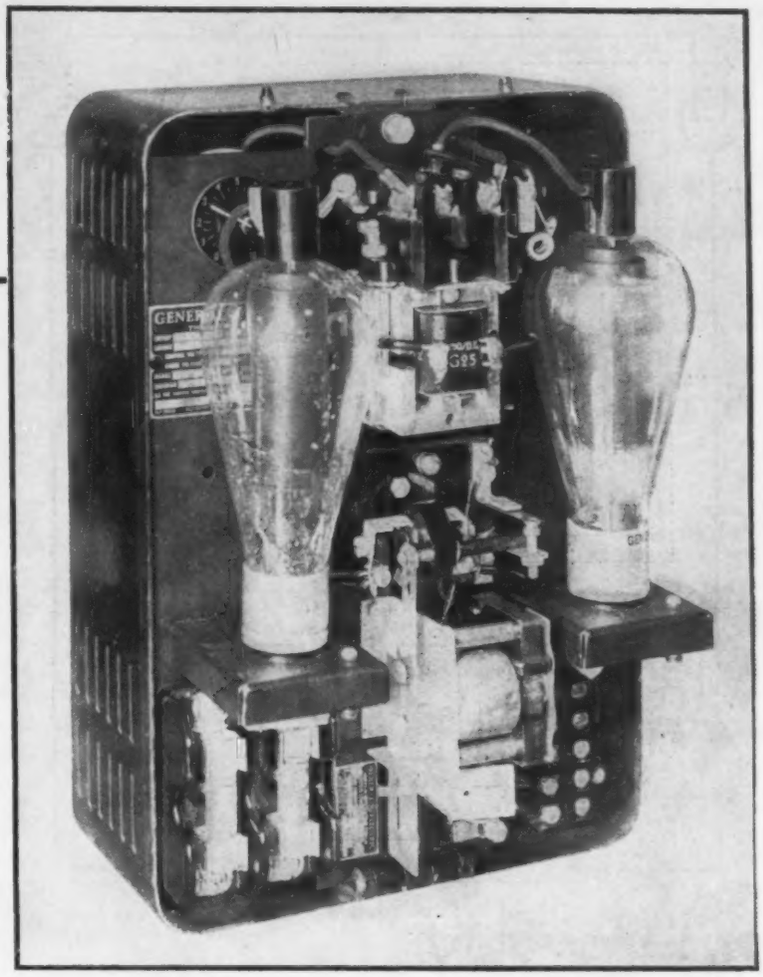

FIG. 3—Enclosed thyratron motor controller for d-c shunt motors

the limited speed range of 3 to 1 or 4 to 1 by field control is sufficient. This speed range can be widened considerably if the armature voltage is varied independently of the field excitation, but this method of speed control is not obtainable from a constant-potential d-c distribution system unless a d-c to d-c motor-generator set is used to obtain the variable armature voltage.

When an a-c network is the only power supply, some form of a-c to d-c conversion equipment must be used to provide a d-c supply for the motor. Otherwise, the alternative is a special form of a-c motor of limited speed range or a constant speed a-c induction motor coupled through a mechanical variable speed transmission or an electromagnetic coupling device.

Where a-c power is available, a simple d-c power supply from which to operate a d-c motor might be the electronic circuit of Fig. 1 which is a biphase rectifier using gaseous discharge tubes. However, so elementary a circuit would require the following additions to become commercially practicable: (1) A filament transformer is needed to supply the low-voltage, high-current filaments of the tubes. (2) A time delay relay and contactor should be used to prevent current flow through the tubes before they have reached operating temperature. (3) Anode fuses are required to isolate defective tubes and to protect the remaining tubes and the transformer from the effect of short circuit currents in both the a-c and d-c circuit paths. (4) Thyrite surge arresters across the transformer and field windings protect these highly inductive circuit elements from the voltage surges which might result if the tubes are operated when not in proper operating condition.

Many of these auxiliary devices are much the same for a given size or complement of tubes, irrespective of a-c supply voltages and/or output voltage within the rating of the tubes. Therefore it is desirable to standardize the frequency and voltage for the excitation of all control devices and to provide taps for this voltage on the secondary of the anode transformer, the taps being spaced equidistant each side of the neutral midtap for the purpose of grid control, if used. The 115-volt, 50/60 cps supply is a convenient type of supply upon which to standardize.

A complete control circuit is shown in Fig. 2 and the photograph of a typical panel in Fig. 3. The same panel may be used with different anode transformers to supply d-c motors of 115-, 230-, or 550-volt ratings from a-c sources of 115, 208, 440, 550 volts, 50/60 cps. In many applications the autotransformer of Fig. 1 may be substituted for the insulating transformer of Fig. 2 and in certain instances, particularly three phase circuit arrangements, the transformer may be omitted entirely. The single phase rectifier circuit combinations usually require some form of voltage transformation in order to operate standard voltage d-c motors from standard voltage a-c systems. The fixed ratio of a-c to d-c voltages, which the type of circuit itself determines, is not the ratio of the standard a-c or d-c distribution system voltages. For example, the circuits of Figs. 1 and 2 require a midtapped a-c voltage of approximately 275 volts rms each side of midtap in order that the rectified d-c output will be 230 volts and this particular voltage ratio, namely, 550/275 volts, is not a common for distribution transformers.

Gaseous discharge tubes are basically current-rated devices whose maximum current is determined by the nature of the cathode and the geometry of the tube and whose continuous current rating is a function of the tube's ability to dissipate the heat generated within its structure.

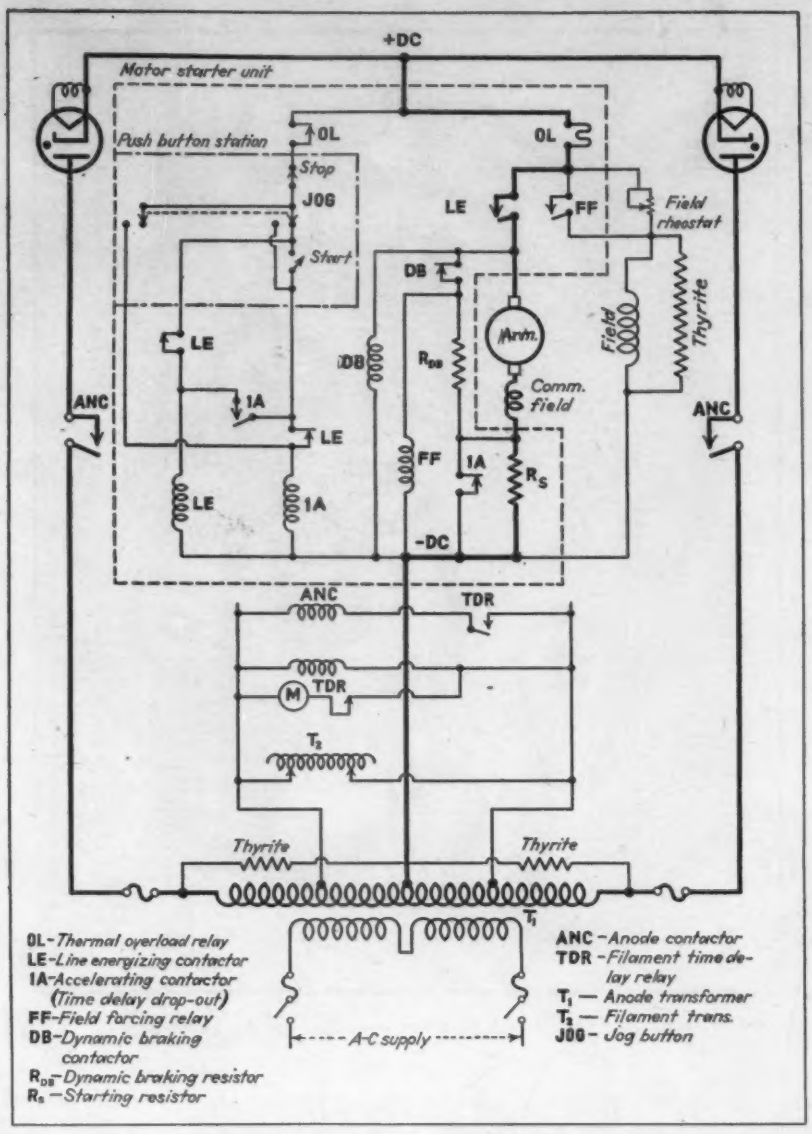

FIG. 4—Rectifier, auxiliaries and motor starter for d-c shunt motor controlled by electron tubes

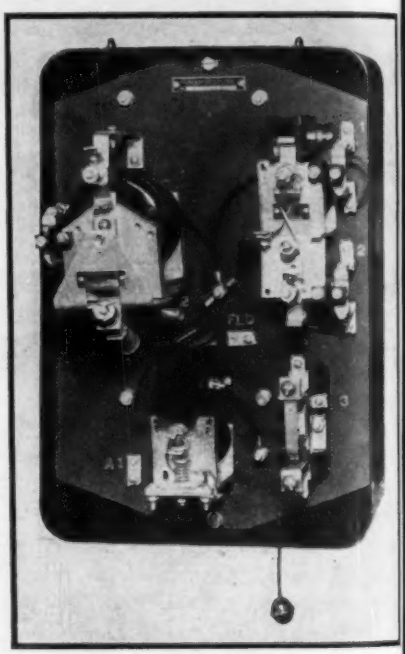

FIG. 5—Magnetic non-reversing two point controller providing adjustable speed and dynamic braking

Because so little material goes into the construction of a tube, the current being conducted through the gaseous discharge rather than through copper conductors, these tubes have very little thermal storage capacity by which to absorb the additional internal heating which would accompany sustained overloads. They have no energy storage so that the current which leaves at the cathode must enter simultaneously at the anode. By contrast, a d-c generator has an appreciable thermal storage because the mass of material of which it is constructed is able to absorb the additional heating incident to prolonged overloads, and it has considerable energy storage in the form of inertia of the rotating mass of the armature. Hence, when gaseous discharge tubes are used to supply a motor load, consideration must be given to the nature and amount of the current which may be demanded of the tubes as well as to the effect of the current wave shape on the performance of the motor.

Just as the tubes have a maximum current rating, so too does the d-c motor have a maximum current which it will commutate successfully, and it is one of the functions of a motor control to limit the starting, accelerating, running, and decelerating currents within this maximum rating. Small d-c motors (usually fractional horsepower sizes) may have sufficient internal impedence to limit the starting and accelerating currents to values which will not damage the motor or paralyze the d-c power supply but the control for larger motors must include a current-limiting means external to the motor itself. The circuit of Fig. 4 includes a standard push-button operated motor-starter which, in this case, consists of a resistance R_s connected in series with the motor armature and a contactor 1A so arranged that at a certain definite time after the starting is initiated, the contactor will drop out and short-circuit the series resistor R_s and will simultaneously cause another contactor *FF* to release the full-field shorting around the field rheostat so as to allow the motor speed to rise to whatever speed the weak-field setting of the rheostat determines.

Overload protection is by means of a thermally actuated relay *OL* which responds approximately to the I^2R heating of the armature conductors. For stopping, a resistor R_{DB} is connected across the motor armature to dissipate the energy of the armature and its shaft load and thus provide rapid dynamic-braking of the motor speed to a low value from which it may be mechanically braked to a dead stop if the frictional losses are not sufficient to bring it to a coasting stop in a reasonable time. This motor-starter unit is shown in Fig. 5. An even smaller size base and enclosure is used for the panel of Fig. 3; this panel in combination with an anode transformer of approximately half the volume, wi

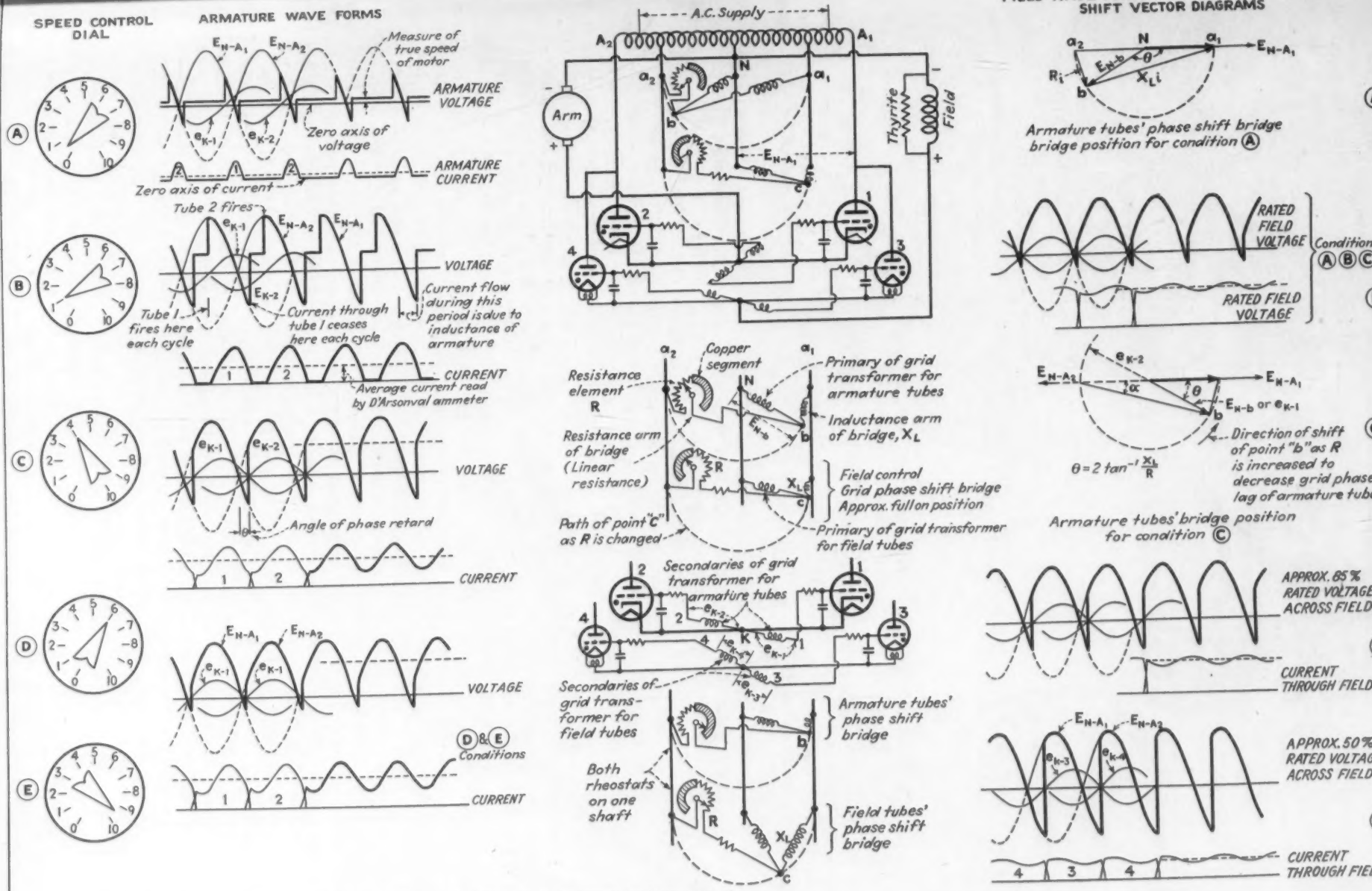
SPEED CONTROL DIAL
ARMATURE WAVE FORMS
Measure of true speed of motor
ARMATURE VOLTAGE
Zero axis of voltage
ARMATURE CURRENT
Zero axis of current
Tube 2 fires
VOLTAGE
Current flow during this period is due to inductance of armature
Tube 1 fires here each cycle
Current through tube 1 ceases here each cycle
CURRENT
Average current read by D'Arsonval ammeter
Angle of phase retard
D & E Conditions
A.C. Supply
Arm
Thyrite
Field
Copper segment
Primary of grid transformer for armature tubes
Resistance element R
Inductance arm of bridge, X_L
Resistance arm of bridge (Linear resistance)
Field control Grid phase shift bridge Approx. full on position
Path of point "C" as R is changed
Primary of grid transformer for field tubes
Secondaries of grid transformer for armature tubes
Secondaries of grid transformer for field tubes
Armature tubes' phase shift bridge
Both rheostats on one shaft
Field tubes' phase shift bridge
FIELD WAVE FORMS AND ARMATURE PHASE SHIFT VECTOR DIAGRAMS
Armature tubes' phase shift bridge bridge position for condition A
RATED FIELD VOLTAGE
Conditions A B C
Direction of shift of point "b" as R is increased to decrease grid phase lag of armature tubes
Armature tubes' bridge position for condition C
APPROX. 85% RATED VOLTAGE ACROSS FIELD
CURRENT THROUGH FIELD
APPROX. 50% RATED VOLTAGE ACROSS FIELD

FIG. 7—Variable voltage drive, with motor starting, accelerating, and dynamic braking control

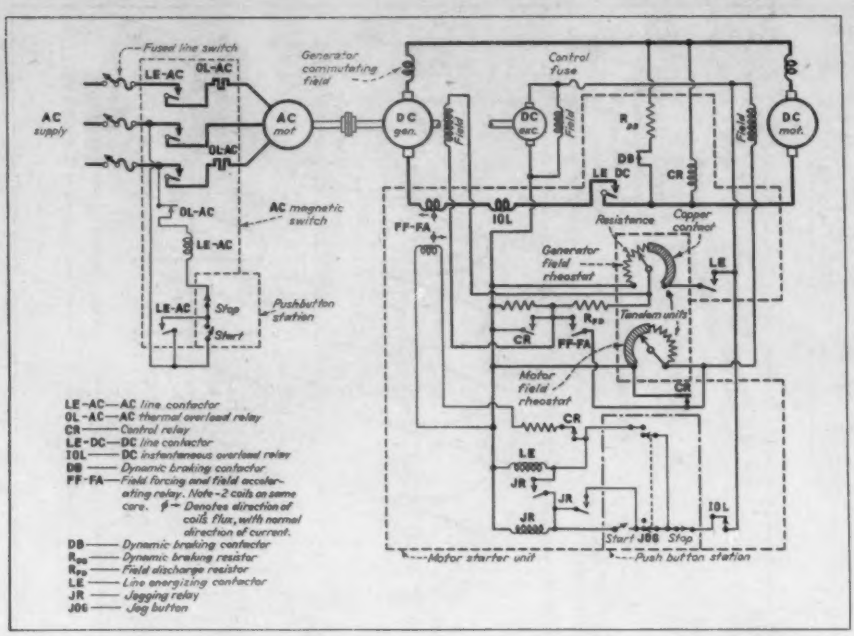

FIG. 6—Electronic variable voltage drive for d-c shunt motor

provide excitation for a 1-hp motor, indicating the space-saving possibilities of electronic equipment.

For those applications which require a much greater speed ratio than is available by field weakening alone, the d-c variable-voltage drive has been almost universally used. A typical drive, as diagrammed in Fig. 6, provides a variable armature voltage as well as a variable field excitation for the d-c motor. The control is such that from a speed of perhaps say 10 percent of basic speed up to basic speed, the speed is determined by the armature voltage applied to the motor while the field is at full strength; from basic speed up to the maximum speed for which the motor is designed, say 3 times basic speed, the speed is set by the reduced field excitation. ("Basic" speed is the rated speed of the motor operated at rated armature voltage and rated field current). Thus, a speed change of 10 to 1 by armature voltage control and 3 to 1 by field weakening becomes an over-all speed range of 30 to 1.

Thyratron tubes in rectifier circuits may be grid-controlled to provide variable voltage to a motor in much the same sense as does the generator in Fig. 6. If the circuit of Fig. 2 is modified by substituting two sets of grid-controlled thyratron tubes for the one set of diode rectifier tubes, the electronic variable-voltage drive of Fig. 7 will operate the d-c motor over the same wide speed range as the rotating equipment of Fig. 6.

Furthermore, in view of the present war-time demand for d-c machines and the consequent scarcity thereof, substituting the electronic control of Fig. 7 in place of the motor-generator drive of Fig. 6 has the advantages of releasing one d-c generator which, in combination with another electronic control could become the motor for another drive, and of freeing one induction motor for use elsewhere, besides having left over a small d-c exciter which could be used for some constant-speed motor application.

Another point in favor of electronic control is the fact that the control rheostats are so much smaller and more compact than the field rheostats which are used to control field current directly. In fact the, same grid control devices of Fig. 7 could be applied to any electronic drive whether ½ hp or 5 hp. However, it should be pointed out that the mere use of electronic tubes to provide variable-field excitation to any d-c motor will not successfully extend its speed range unless the motor itself has been designed to operate under weak-field conditions whether supplied from tubes or a generator.

The wide range of speed which is made available by variable-armature voltage in combination with variable-field excitation is not to imply that rated motor horsepower is available at all speeds. At very low speeds, the armature current must be reduced below the rated value at basic speed, because of the reduced air cooling effect upon the armature conductors. This is true whether the motor is operated from electron tubes or from a generator.

When the motor speed is determined by armature voltage control at full field the power output of the motor is reduced proportionately as the speed is reduced but the torque, or "twisting effort" at the shaft, will be constant at full-load value if rated full-load armature current flows. This is the operating region of constant torque and variable horsepower. Conversely, when, at constant armature counter e.m.f., the speed is determined by field weakening, the horsepower output of the motor remains constant, throughout the increase in speed if rated armature current flows, but the torque decreases as the field is weakened to increase the speed. This is the operating region of constant horsepower and variable torque.

One very important feature of the motor-generator type of variable-voltage drive of Fig. 6 (which is difficult to obtain when tubes are substituted as in Fig. 7) is the braking action which spontaneously results when the setting of the speed control rheostats is changed from a high speed to a lower speed or when an overhauling load tends to run the motor at a speed higher than that for which it is set to operate. In either instance the d-c motor acts as a generator and the d-c generator as a motor to pump power back into the a-c system via the a-c driving motor which acts as an a-c generator. This regenerative action tends quickly to hold the motor speed down to the speed control setting. Since it is a fundamental action of electron tubes, as now made and used, to pass current in one direction only, the tube circuit of Fig. 7 cannot permit the reversal of current which must accompany a transfer of power from the d-c side to the a-c system. So, when subjected to an overhauling load, the terminal voltage of the motor rises and the motor "free-wheels" in a mechanical sense. This limitation is greatly minimized when reversing contactors are used as part of a reversing control scheme as will be explained in more

detail later. Furthermore, many of the simpler applications are not basically of an overhauling nature and have sufficient frictional losses that the matter is not as serious as at first it may have seemed. However, it is another reason why the nature of the mechanical load is a factor to be considered when applying electronic control to motors

Either drive, that of Fig. 6 or that of Fig. 7, will have speed regulation as the motor is loaded. That is, if preset for a certain speed under no-load conditions, the speed will decrease as the motor is loaded. This may not be too objectionable in the higher speed regions as shown in Fig. 8. However, it becomes an actual limitation in the low-speed range where, at full load, the voltage drops of both motor and generator may equal the no-load output voltage of the generator as shown in Fig. 8 so that the motor speed would drop to zero when fully loaded and yet would rise to some definite value whenever the load was removed. If the motor speed is to be held constant from no-load to full-load, some means must be provided to increase the generator induced voltage, as by increasing the field excitation in proportion to the sum of the voltage drops of generator and motor. On a motor generator set drive, this compensation may take the form of a booster generator whose voltage output is a function of motor current; with thyratron tube control it is accomplished by the addition of a small transformer and a vacuum tube.

Thyratron tubes are grid controlled in a manner somewhat analogous to the ignition timing of a gasoline engine. That is, the grid acts much as a spark plug to determine when, during the cyclic interval in which the tube anode is positive with respect to the cathode, the tube will fire and begin to conduct current from anode to cathode. Once current has begun to flow, it is not the grid but rather the natural action of the anode power circuit which must make the current zero; then the grid can regain the control by which it prevents conduction until the firing point of the next positive interval. This is not the same behavior as the grid in a high vacuum tube wherein the grid has complete control of the current whenever current does or could flow.

The thyratron tube may be thought of as a synchronous switch which, during each positive half cycle of the alternating voltage wave, connects the a-c supply to the d-c load and permits current to flow through the tube in a direction from anode to cathode. The grid control action determines how much of each positive half cycle of the a-c voltage wave shall be utilized and how much is unused. If the early part of each successive wave is unused, and only the latter portion of each wave is transmitted by the tubes to the load, then the full voltage which could be made available at the load is reduced in proportion to the area of the voltage wave which is actually utilized. If the firing point is delayed until almost the end of each positive half cycle, then very little voltage area remains to be transmitted to the load circuit and the rectifier output voltage is very much reduced. Conversely, if the firing is advanced to the beginning of the voltage wave, the d-c output voltage is the maximum value possible for a given rms anode-to-neutral voltage in combination with a given circuit arrangement of the tubes.

The sketches of Fig. 7 show the approximate wave forms of output voltages and currents for various degrees of grid phase shift and for the two different types of load circuits represented by the counter e.m.f. of the armature and the highly inductive field. The armature tubes supply the armature directly, without benefit of a d-c smoothing reactor or other external means of absorbing the instantaneous differences between the output voltage of the tube and the counter e.m.f. of the armature. Therefore the armature current will flow in pulses as each tube passes current for the relatively short interval when its anode voltage is greater than the armature counter e.m.f.

A d-c ammeter (D'Arsonval permanent-magnet type instrument) connected to read armature current will give a steady reading of the average value of these pulses as shown by the dotted line in the sketches because the meter is too sluggish to respond to the current pulsations. This pulsing nature of the armature current tends to produce more heating in the armature conductors than would be produced by a continuously flowing current of the same meter reading. In other words, the rms value of an intermittent or pulsating armature current is greater than the average value. An rms (current-squared type) of instrument in series with a permanent-magnet type instrument reading average values would result in two unlike readings, the rms value always being the greater. The armature itself has inductance which acts to a limited extent like a d-c reactor and tends to widen out the current pulses and reduce their peak heights. Beyond certain values of current this inductance may cause the tube current pulses to overlap and produce a continuous output current with appreciable ripple superimposed. The pulsating nature of

(Continued on page 215)

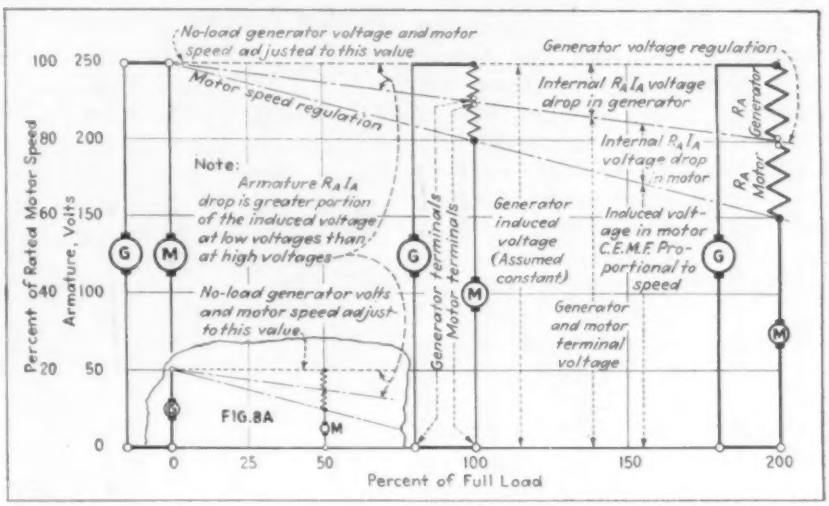
No-load generator voltage and motor speed adjusted to this value
Generator voltage regulation
Motor speed regulation
Internal $R_A I_A$ voltage drop in generator
R_A Generator
Internal $R_A I_A$ voltage drop in motor
R_A Motor
Note:
Armature $R_A I_A$ drop is greater portion of the induced voltage at low voltages than at high voltages
Generator induced voltage (Assumed constant)
Induced voltage in motor C.E.M.F. Proportional to speed
No-load generator volts and motor speed adjust to this value
Generator terminals
Motor terminals
Generator and motor terminal voltage
FIG. 8A
Percent of Rated Motor Speed
Armature, Volts
100 250
80 200
60 150
40 100
20 50
0
0 25 50 100 150 200
Percent of Full Load

FIG. 8—Speed regulation caused by voltage drop in armatures of motor and generator

Narrow Band-Pass Filter P

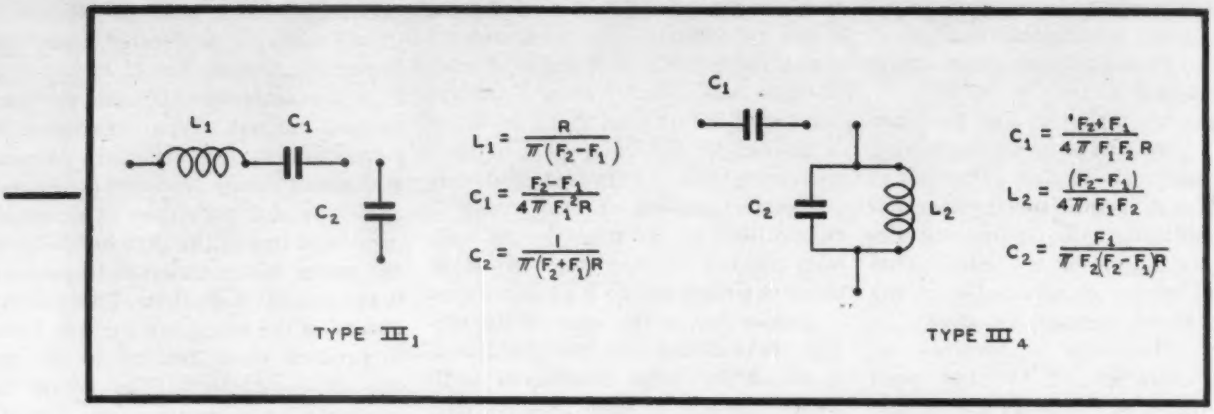

FIG. 1—Types of unsymmetrical band-pass filters; type III_1 has greater attenuation above pass band; type III_4 has higher attenuation below pass band. Type III_1 has higher impedance at frequencies away from pass band. R= terminating resistance; F_2= upper cutoff and F_1= lower cutoff frequency.

FOR control or experimental purposes, filters of the type which pass only narrow bands are often used. These filters may be symmetrical (constant K) or unsymmetrical in general type; the characteristics of the two types differ somewhat, and it is to the advantage of the engineer to be able to determine quickly which type he should employ. By means of certain simplifications in method, it is possible to use the nomograms given and derived here without too much loss in accuracy.

In addition to symmetrical band-pass filters with constant K, unsymmetrical filter types III_1 and III_4* shown in Fig. 1 are of considerable importance. Although the attenuation characteristics of these two types are not as steep as those of the constant K type, their inherently lower insertion loss at the midband frequency makes their use desirable for certain applications. This is especially true in the very narrow band-pass filters where the insertion losses at the midband frequency of the symmetrical filter become too large. The attenuation of either of the two types of filters is not symmetrical, the attenuation being much greater at frequencies above the pass band with type III_1, and below the pass band with type III_4. Because of the higher impedance at frequencies away from the pass band, the type III_1 is used in preference to type III_4.

The performance of these filters may be predetermined either from the relation

$$\cosh \alpha = 1 + (Z_1/Z_2)$$

or graphically from $Z_1/4Z_2$. It is, however, felt that both of these methods are too lengthy, and much quicker methods can be used.

Considering filter type III_1, and neglecting dissipation in the condensers, the following relation may be obtained for the series arm impedance Z_1 at any frequency F

$$Z_1 = j2\pi FL_1 - j\frac{1}{2\pi FC_1} + \frac{2\pi FL_1}{Q}$$

where $Q = 2\pi FL/r = 1/d$,

d is the dissipation factor and r is the resistance of the coil.

Inserting the expressions for L_1 and C_1 from Fig. 1, and simplifying, the following is obtained

$$Z_1 = j\frac{2R(F^2 - F_1^2)}{F(F_2 - F_1)} + \frac{2RF}{Q(F_2 - F_1)}$$

Similarly, the shunt arm impedance is

$$Z_2 = -j\frac{(F_2 + F_1)R}{2F}$$

Then $$\frac{Z_1}{2Z_2} = -\frac{2(F^2 - F_1^2)}{(F_2 - F_1)(F_2 + F_1)} + j\frac{2F^2}{Q(F_2 - F_1)(F_2 + F_1)}$$

or $$\frac{Z_1}{2Z_2} = -\frac{2(F^2 - F_1^2)}{F_2^2 - F_1^2} + j\frac{2F^2}{Q(F_2^2 - F_1^2)} \quad (1)$$

Filter Performance

The theoretical attenuation of the filter may now be determined from the relation

$$\cosh \alpha = 1 + \frac{Z_1}{2Z_2} = 1 - \frac{2(F^2 - F_1^2)}{F_2^2 - F_1^2}$$

The relation

$$\frac{Z_1}{2Z_2} = -\frac{2(F^2 - F_1^2)}{F_2^2 - F_1^2} = -2\frac{(F/F_1)^2 - 1}{(F_2/F_1)^2 - 1} \quad (2)$$

$$= -2\frac{(F/F_2)^2 - (F_1/F_2)^2}{1 - (F_1/F_2)^2}$$

$$= -2\left[1 + \frac{(F/F_2)^2 - 1}{1 - (F_1/F_2)^2}\right] \quad (3)$$

The two alignment charts in Fig. 2 are constructed using relations (2) and (3) for $Z_1/2Z_2$ in the formula

$$\cosh \alpha = 1 + Z_1/2Z_2,$$

and may be used for a quick determination of the theoretical performance of type III_1 filters since Fig. 2 gives the attenuation at any frequency in the pass band and Fig. 3 gives the minimum insertion loss.

Unlike the constant K section, the lowest insertion loss for this type of filter does not occur exactly at mid-band, but takes place when

$$-2\frac{F^2 - F_1^2}{F_2^2 - F_1^2} = -1$$

for in this case

$$\cosh \alpha = 1 + \frac{Z_1}{2Z_2} = j\frac{2F^2}{Q(F_2^2 - F_1^2)},$$

and α is a minimum.

Solving $$-2\frac{F^2 - F_1^2}{F_2^2 - F_1^2} = -1$$

* Shea, T. E., *"Transmission Networks and Wave Filters,"* D. Van Nostrand Co., 1929, p. 316.

Performance

By HARRY HOLUBOW

Engineering and Research Division
Thordarson Electric Manufacturing Co.
Chicago, Ill.

Charts enabling one to design quickly a filter of desired characteristics. For given cutoff frequencies and coil Q, the minimum attenuation, attenuation at cutoff frequencies and the actual curve may be obtained. Time spent in trial design is reduced to a few minutes

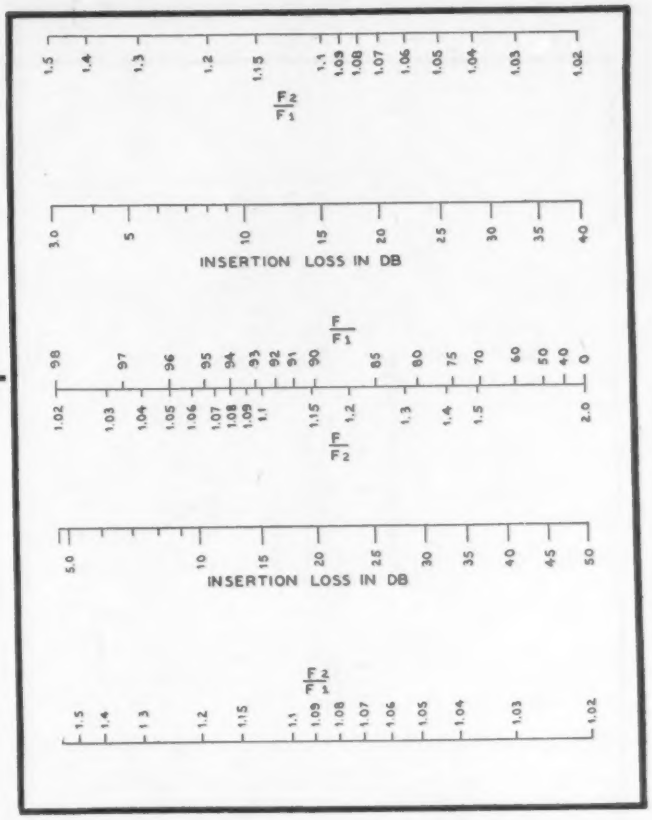

FIG. 2—Alignment chart giving insertion loss in filters described. F_1 and F_2 are the cutoff frequencies; F is any frequency inside the pass band. Upper three scales are for region below F_1; lower scales are for region above F_2

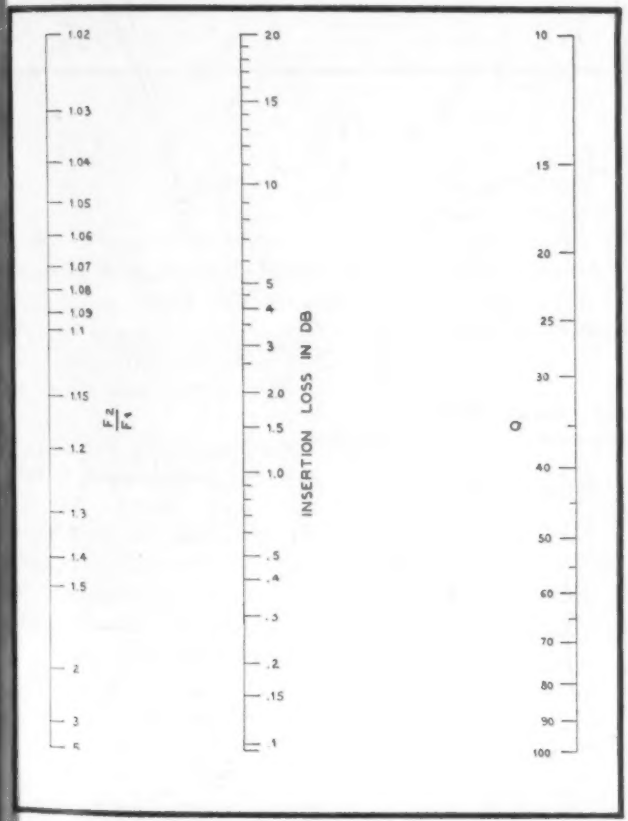

FIG. 3—Charts giving minimum loss in using an unsymmetrical filter of the types described. This occurs at the frequency which is equal to 0.707 $\sqrt{F_2^2 + F_1^2}$

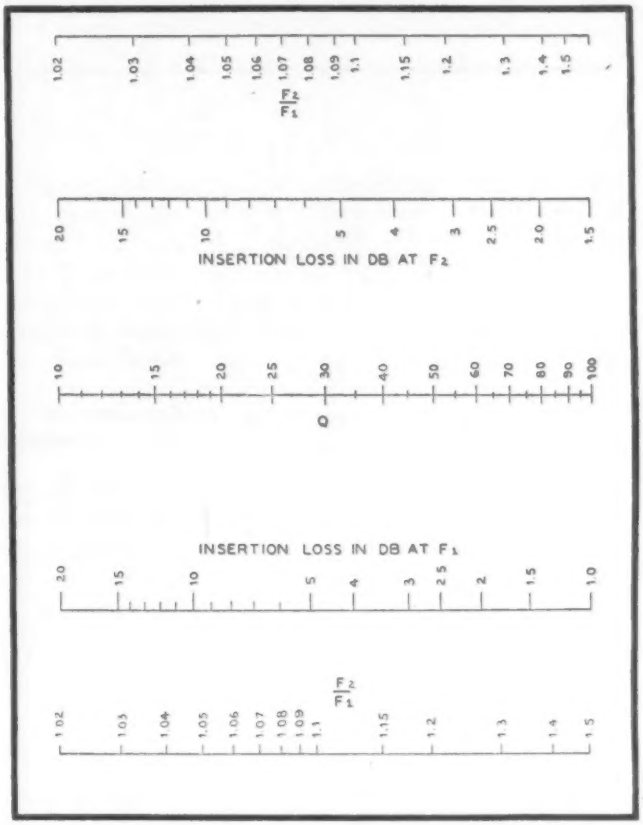

FIG. 4—Insertion loss at the cut-off frequencies in unsymmetrical type III_1 band-pass filters. This chart may be used for a type III_4 filter if the values of F_1 and F_2 are interchanged

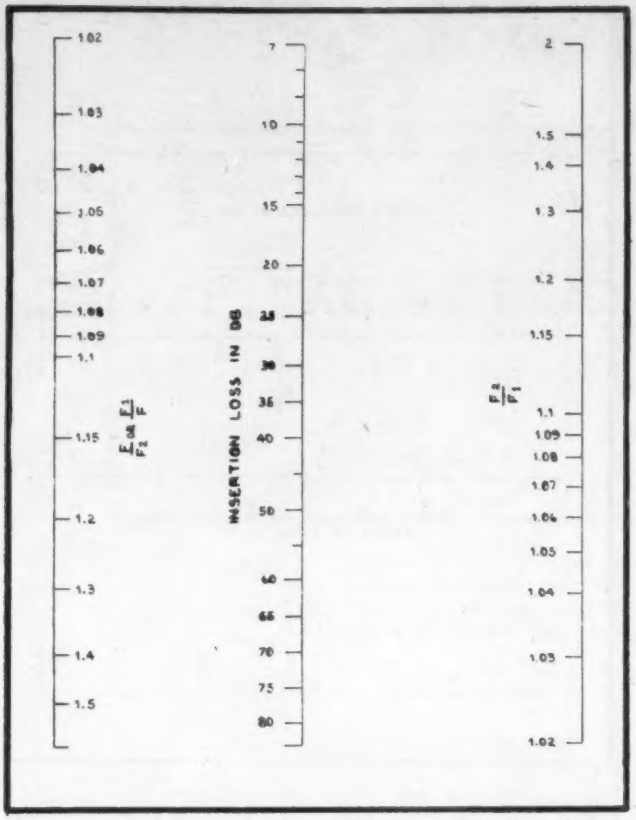

FIG. 5—Alignment chart of insertion loss in symmetrical (constant K) band-pass filters

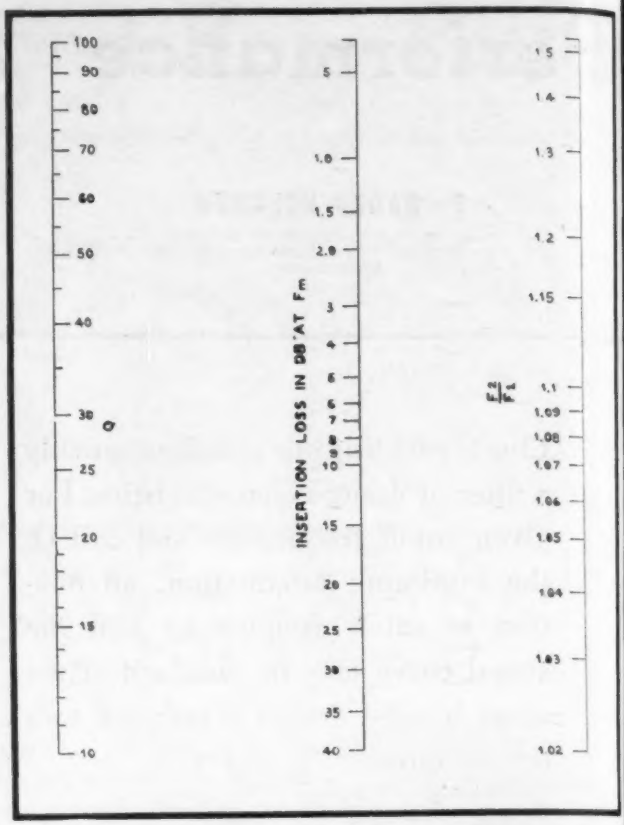

FIG. 6—Insertion loss at the midband in constant K band-pass filter. Reflection losses do not appreciably affect these values

We have $F^2 = 0.5\,(F_2^2 + F_1^2)$, or the point of minimum insertion loss takes place for a frequency

$$F = 0.707\sqrt{F_2^2 + F_1^2} \qquad (4)$$

At the point of minimum attenuation

$$\cosh \alpha = \frac{F_2^2 + F_1^2}{Q(F_2^2 - F_1^2)} = \frac{(F_2/F_1)^2 + 1}{Q[(F_2/F_1)^2 - 1]} \qquad (5)$$

The nomogram shown in Fig. 3 is based on this equation. At the cut-off point where $F = F_1$,

$$\frac{Z_1}{2Z_2} = j\frac{2F_1^2}{Q(F_2^2 - F_1^2)}$$

and $$\cosh \alpha = 1 + j\frac{2F_1^2}{Q(F_2^2 - F_1^2)} \qquad (6)$$

while at the cut-off point $F = F_2$ the attenuation may be expressed as

$$\cosh \alpha = -1 + j\frac{2F_2^2}{Q(F_2^2 - F_1^2)} \qquad (7)$$

Alignment charts in Fig. 4 may be used to find the insertion loss at the cut-off points.

Now the entire response curve of the filter may be found by using Fig. 2 to determine the attenuation within the pass band. The minimum attenuation and the attenuation at the cutoff frequencies can be found by using Figs. 3 and 4 respectively. The approximate performance is found by drawing a curve through these points.

Characteristics of Filter Having Anti-Resonant Shunt Arm

Similarly, for the band-pass filter type III$_1$ shown in Fig. 1, it may be shown that

$$\frac{Z_1}{2Z_2} = \frac{-j\,2F_1^2\,[F^2 + jQ\,(F^2 - F_2^2)]}{(Q - j1)\,F^2\,(F_2^2 - F_1^2)}$$

After eliminating the imaginary in the denominator

$$\frac{Z_1}{2Z_2} = \frac{2F_1^2\,(F^2 - F_2^2)}{F^2\,(F_2^2 - F_1^2)} + \frac{2F_1^2}{Q^2(F_2^2 - F_1^2)} - j\frac{2F_1^2}{Q(F_2^2 - F_1^2)} + j\frac{2F_1^2(F^2 - F_2^2)}{QF^2(F_2^2 - F_1^2)}$$

The expression of $Z_1/2Z_2$ is much more complicated than the one obtained for type III$_1$. It may be simplified, however, by neglecting

$$\frac{2F_1^2}{Q^2(F_2^2 - F_1^2)}$$

The error introduced by this omission is slight even if Q is only 25 and F_2/F_1^2 is 1.02. Then

$$\frac{Z_1}{2Z_2} = \frac{2F_1^2(F^2 - F_2^2)}{F^2(F_2^2 - F_1^2)} - j\frac{2F_1^2}{Q(F_2^2 - F_1^2)} + j\frac{2F_1^2(F^2 - F_2^2)}{QF^2(F_2^2 - F_1^2)} \qquad (8)$$

While the equation for $Z_1/2Z_2$ still seems somewhat complicated, it can be handled quite easily. In the method just outlined, the imaginary part of the expression $Z_1/2Z_2$ is used mainly to calculate the performance at F_1 and F_2, and the minimum insertion loss from Eq. (8).

When $F = F_1$,

$$\frac{Z_1}{2Z_2} = -2 - j\frac{2F_1^2}{Q(F_2^2 - F_1^2)} \qquad (9)$$

and when $F = F_2$,

$$\frac{Z_1}{2Z_2} = -j\frac{2F_2^2}{Q(F_2^2 - F_1^2)} \qquad (10)$$

Equations (9) and (10) are the same as (6) and (7) except that the

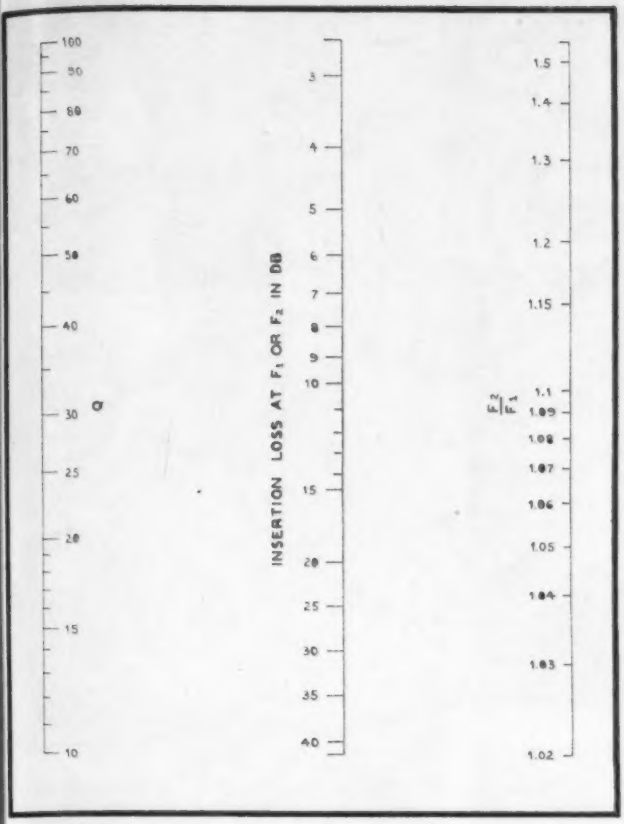

FIG. 7—Insertion loss of cutoff points in constant *K* filter. Actual attenuation will be greater due to reflection losses

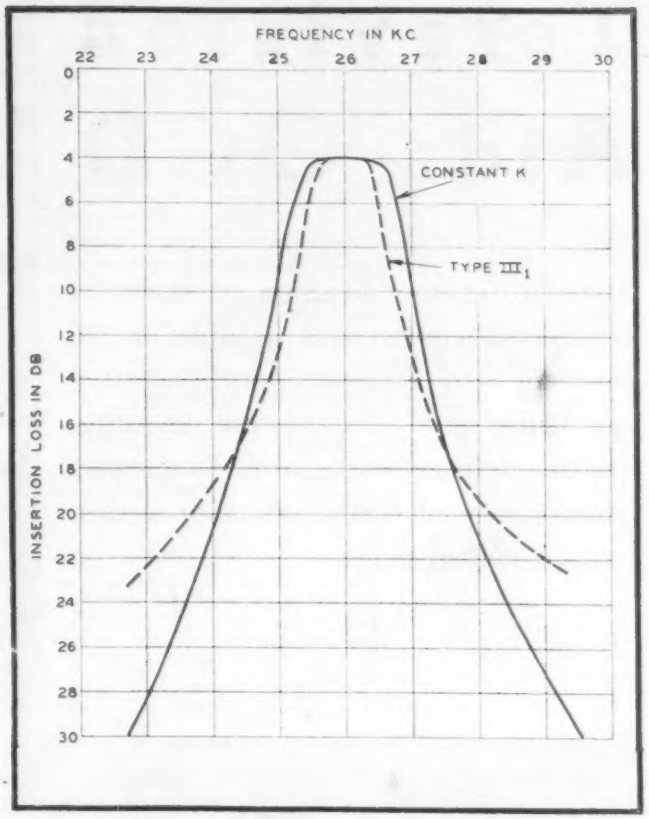

FIG. 8—Calculated performance of constant *K* versus type III_1 filters when coil Q is assumed equal to 50

insertion loss at F_1 for type III_4 is the same as at F_2 for type III_1 and at F_2 the same as F_1. The alignment chart in Fig. 4 may then be used for both types except that the values for F_2 and F_1 are interchanged when applying to a type III_4 filter.

In the same manner, the real part of Eq. (8),

$$\frac{2F_1^2[1-(F_2/F)^2]}{F_2^2-F_1^2}$$

compares with the real part of Eq. (1) which can be written as

$$\frac{2F_1^2[1-(F/F_1)^2]}{F_2^2-F_1^2}.$$

From these relations it can be seen that the theoretical performance of type III_4 filters may be obtained from the alignment charts in Fig. 2 if for values of F_2/F the values of F/F_1 are used; similarly, F/F_2 of type III_1 are used to calculate F/F_1 of type III_4.

The point of minimum insertion loss in this type of filter occurs where

$$F=\frac{\sqrt{2}F_1F_2}{\sqrt{F_2^2+F_1^2}} \qquad (11)$$

Substituting this value for F in Eq. (10), the expression at minimum insertion loss is

$$\cosh\alpha=\frac{F_2^2+F_1^2}{Q(F_2^2-F_1^2)}$$

This is similar to Eq. (5), and the nomogram in Fig. 3 may be used.

Thus we see that the performance of both filter types may be obtained from the same set of alignment charts.

Application to Constant K Filters

The charts in Figs. 5, 6, 7 are obtained in the same manner for use with the constant *K* type filter, and are especially applicable in calculating the performance of narrow band filters. None of these charts take into account reflection losses. The actual attenuation in the constant *K* type and type III_1 will be greater than obtained at points away from the midband. The performance near the midband will not depart greatly from the values obtained by means of these nomograms.

To compare the performance of the two types of filters, calculated performances of type III_1 and of the constant *K* type are shown in Fig. 8.

The *Q* of the coils were assumed to be 50 and the ratio F_2/F_1 for the two types was selected so as to give the same midband insertion loss. The ratios are 1.09 for the constant *K* type and 1.04 for the unsymmetrical type. From the curve we can see that if the performance in the vicinity of the midband is more important, the unsymmetrical filter may be used. The saving in space, weight, and cost will be approximately 20 percent.

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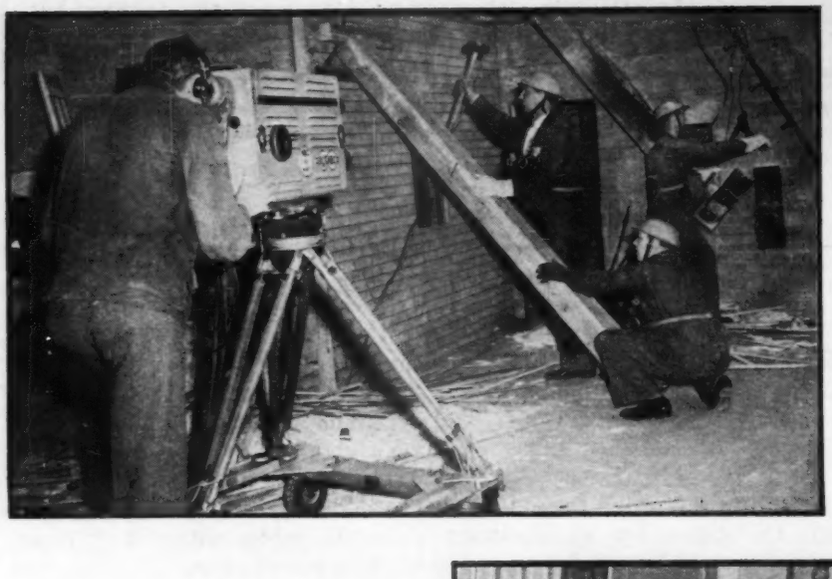
Stymied for the duration of the war insofar as commercial application is concerned, transmitters and receivers are being put to good use training civilian defense workers in the proper performance of their important duties from a central point



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DEMOLITION—Experts show distant defense workers how best to prop up a shaky wall and handle dangerous trailing electric wires

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Electronics Bibliography for WAR TRAINING

EFFECTIVE production for our war effort requires the services of highly trained technical personnel in a variety of fields. The rapid advancements which are being made in the electronics and radio fields, and the unusually heavy demand for skilled engineers and technicians, places a heavy burden upon instructors and students alike in the many training courses now in operation.

This bibliography has been prepared to meet the many requests which the editors of Electronics have received for a list of available books suitable for self study or classroom instruction in physics, acoustics, electronics, and radio. The list includes elementary as well as advanced works; contains books on service and maintenance as well as those on theory.

PUBLISHERS

American Institute of Electrical Engineers, 33 W. 39th St., New York, N. Y.

American Radio Relay League, West Hartford, Conn.

Ernest Benn, Ltd., 24 High St., Colchester, Essex, Eng.

Blakiston Co., 1012 Walnut St., Philadelphia, Pa.

Bookniga Corp. (Four Continent Book Co.), 255 Fifth Ave., New York, N. Y.

Chapman and Hall, 11 Henrietta St., Convent Garden, London.

Chemical Rubber Publishing Co., Cleveland, O.

Harper and Brothers, 49 East 33rd St., New York, N. Y.

International Textbook Co., Scranton, Pa.

Interscience Publishers, 215 Fourth Ave., New York, N. Y.

J. B. Lippincott, 227 S. 6th St., Philadelphia, Pa.

Longmans, Green and Co., 55 Fifth Ave., New York, N. Y.

Macmillan Co., 60 Fifth Ave., New York, N. Y.

McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y.

Pitman Publishing Corp., 2 W. 45th St., New York, N. Y.

Prentice-Hall, 70 Fifth Ave., New York, N. Y.

Radio and Technical Publishing Co., 45 Astor Place, New York, N. Y.

RCA Mfg. Co., Harrison, N. J.

Reinhold Publishing Corp., 330 West 42nd St., New York, N. Y.

John F. Rider Publisher, 404 Fourth Ave., New York, N. Y.

Ronald Press Co., 15 East 26th St., New York, N. Y.

Simmons-Boardman, 30 Church St., New York, N. Y.

G. E. Stechert and Co., 31 East 10th St., New York, N. Y.

University of Chicago Press, U. of C., Chicago, Ill.

John Wiley and Sons, 440 Fourth Ave., New York, N. Y.

D. Van Nostrand Co., 250 Fourth Ave., New York, N. Y.

I HANDBOOKS

American Standard Definitions of Electrical Terms—*By A.I.E.E. American Institute of Electrical Engineers, 311 p, $1.00, 1942.*

A glossary of electrical engineering terms covering general terms, rotating machinery, transformers and rectifiers, switching and control equipment, instruments, electronics, and other branches of electrical engineering.

Dictionary of Radio Terminology in the English, German, French and Russian Languages—*By A. S. Litvinenko and V. I. Bashenoff, Bookniga Corp. 558 p, 1937.*

Dictionary of Applied Physics—*By Sir R. Glazebrook, Macmillan & Co., 5 vol., $15.00 per vol., 1922-23.*

Glossary of Physics—*By LeRoy D. Weld. McGraw-Hill Book Co., 255 p, $2.50, 1937.*

A glossary of technical terms, arranged alphabetically, and covering the general field of physics.

Handbook of Physics and Chemistry—*Chemical Rubber Publishing Co., Cleveland, 2100 p, $6.00, revised annually.*

A ready-reference book of chemical and physical data.

Handbook of Engineering Fundamentals—*By O. W. Eshbach, John Wiley & Sons, 1098 p, $5.00. 1936.*

Fundamental theory underlying engineering practice.

Standard Handbook for Electrical Engineers—*Edited by A. E. Knowlton (1941), McGraw-Hill Book Co., 2303 p, $8.00, 1941.*

A standard reference work covering all phases of modern electrical engineering, with separate chapter on radio and another on electronics.

Communication and Electronics, Vol. 5 of Electrical Engineers Handbook—*Edited by Pender and McIlwain, John Wiley and Sons. 1022 p, $5.00, 1936, 3rd ed.*

A separate volume of the "Handbook for Electrical Engineers" devoted to communications and electronics.

Radio Engineering Handbook—*Edited by K. Henney. McGraw-Hill Book Co. 945 p, $5.00, 1941.*

A convenient design and reference work devoted entirely to radio engineering.

Radio Engineer's Handbook—*By F. E. Terman. McGraw-Hill Book Co. 995 p, (in press).*

Radio Amateur's Handbook—*American Radio Relay League, West Hartford, Conn., 480 p, $1.00, 20th ed. Revised annually.*

Elementary text on radio fundamentals and principles, with practical construction data and operating and regulatory material, especially prepared for radio amateurs.

Handbook of Broadcasting—*By Waldo Abbot, McGraw-Hill Book Co., 2nd ed., 422 p, $3.50, 1941.*

Instructive material on all phases, except engineering, of production of radio programs.

Tube Handbook (Technical characteristics of transmitting and receiving tubes)—*RCA Manufacturing Co. $6.00.*

A loose-leaf collection of commercial and technical operating ratings and data on all receiving transmitting, cathode-ray, and phototubes made by RCA.

The Engineer's Manual—*By R. G. Hudson, John Wiley & Sons. 389 p, $2.75, 2nd ed., 1939.*

Convenient consolidation of formulas and constants which the engineer employs.

Sprinkle's Conversion Formulas—*By Leland W. Sprinkle, P. Blakiston's Sons & Co., 122 p, $1.25, 1938.*

A compilation of conversion constants relating one system of measurements with another; alphabetically arranged.

II MATHEMATICS

Development of Mathematics—*By E. T. Bell, McGraw-Hill Book Co., 583 p, $4.50.*

Gives knowledge of the part which mathematics has played in evolution of civilization.

Differential Equations for Electrical Engineers—*By Philip Franklin, John Wiley and Sons, 299 p, $2.75, 1933.*

A course on the various types of differential equations which the electrical engineering student and practicing engineer encounters.

Electrical Circuit Theory and Operational Calculus—*By J. R. Carson, McGraw-Hill Book Co., 197 p, $3.00, 1926.*

Introduction to circuit theory and systematic exposition of Heaviside's calculus.

Fourier Series and Boundary Value Problems—*By R. V. Churchill, McGraw-Hill Book Co., 206 p, $2.50, 1941.*

Higher Mathematics for Engineers and Physicists—*By I. S. and E. S. Sokolnikoff, McGraw-Hill Book Co., 483 p, $4.00, 2nd ed., 1941.*

Course on advanced mathematics with emphasis on the practical utilization; for those who have good background in calculus.

Mathematics for Engineers—*By Raymond W. Dull, McGraw-Hill Book Co., 760 p, $5.00, 2nd ed., 1940.*

A reference work and compendium of the important equations in various branches of mathematics up to and including calculus.

Mathematics for Electricians and Radiomen—*By Nelson M. Cooke, McGraw-Hill Book Co., 604 p, $4.00, 1942.*

Elementary mathematics (through trigonometry and complex algebra) applied to radio circuit problems.

Mathematics of Modern Engineering—*By R. E. Doherty and Ernest G. Keller, John Wiley & Sons, 314 p, $3.50, 1936.*

Mathematics needed to solve actual problems arising in engineering.

Mathematics for Electricians—*By M. H. Kuehn, McGraw-Hill Book Co., 254 p, $1.75, 2nd ed., 1941.*

High school or vocational school mathematics with emphasis on their use in electrical problems.

Mathematical Methods in Engineering—*By Theodore V. Karman and M. A. Biot, McGraw-Hill Book Co., 505 p, $4.00, 1940.*

Mathematical treatment of engineering problems, for those having knowledge of calculus.

Higher Mathematics—*By R. S. Burington and C. C. Torrence, McGraw-Hill Book Co., 844 p, $5.00, 1939.*

Advanced course on mathematics with emphasis on physical interpretations of its use; many applications to problems of science and engineering.

Mathematics Applied to Electrical Engineering—*By A. G. Warren, D. Van Nostrand Co., 384 p, $4.50, 1940.*

Applications of mathematical methods to engineering science for those with background of calculus.

Theory and Use of the Complex Variable—*By S. L. Green, Pitman, 136 p, 1939.*

Complex Variable and Operational Calculus with Technical Applications—*By N. W. Mclachlan, Macmillan Co., 355 p, $6.50, 1939.*

Modern treatment of the operational method illustrated by applications to various branches of technology.

An Introduction to the Operational Calculus—*By Walter J. Seeley, International Text Book Co., Scranton.*

A short treatment of operational calculus with particular reference to its use in analysis of electric circuits.

Mathematical Tables—*By H. B. Dwight, McGraw-Hill Book Co., 231 p, $2.50, 1941.*

Tables of elementary and some higher mathematical functions, including trigonometric functions of decimals of decrees and logarithms, exponentials, and hyperbolic trigonometry.

Operational Circuit Analysis—*By Vannevar Bush, John Wiley and Sons, 392 p, $4.50, 1929.*

Operational circuit analysis in a form suitable for engineers and physicists.

A Short Course in Tensor Analysis for Electrical Engineers—*By Gabriel Kron, John Wiley and Sons, 250 p, $4.50, 1942.*

Matrix algebra and tensor methods, with illustrations primarily from the field of electrical power machinery.

Vector Analysis—*By H. B. Philips, John Wiley and Sons, 236 p, $2.50, 1933.*

Mathematical operations with vectors, as required by electrical engineering students.

Tables of Functions with Formulae and Curves—*By Eugen Jahnke and Fritz Emde, G. E. Stechert & Co., 305 p, $6.00, 3rd ed. 1938; reprint 1941.*

Tables and curves of trigonometric, factorial, error integral, theta, elliptical, Bessel, Legendre, Reimann, zeta, and similar functions.

Tables of Integrals and Other Mathematical Data—*By H. B. Dwight, Macmillan Co., 228 p, $1.75, 1934.*

Algebraic, trigonometric, logarithmic, hyperbolic, elliptic, Bessel functions, integrals, differential equations, and numerical values.

III PHYSICS

Introduction to Physics—*By Harley Howe, McGraw-Hill Book Co., 559 p, $3.75, 1942.*

A unified treatment of high school or vocational school physics.

Introduction to Contemporary Physics—*By F. K. Richtmyer and E. H. Kennard, McGraw-Hill Book Co., 723 p, $5.00, 3rd ed.*

Discussion of the origin, development, and present status of some important concepts of physics. A text and reference work.

The Particles of Modern Physics—*By J. D. Stranathan, The Blackiston Co., 571 p, $4.00, 1942.*

A study of the fundamental particles of physics. Extensive references and bibliography make it useful reference work.

Experimental Atomic Physics—*By G. P. Harnwell and J. L. Livingood, McGraw-Hill Book Co., 472 p, $5.00, 1938.*

Development of basic laws of electricity for students with good background in principles.

Introduction to Contemporary Physics—*By K. K. Darrow, D. Van Nostrand Co., 648 p, $7.00, 2nd ed., 646 p, $7.00, 1939.*

A discussion of the recent advances in atomic physics, diffraction of electrons and x-rays by crystals, and wave mechanics.

Introduction to Theoretical Physics—*By John C. Slater and N. H. Frank, McGraw-Hill Book Co., 576 p, $5.00, 1933.*

First year graduate text in physics.

Introduction to Electricity and Optics—*By N. H. Frank, McGraw-Hill Book Co., 398 p, $3.50, 1940.*

Textbook for second year students in physics and electrical engineering. Emphasis is on sound understanding of principles.

Elementary Survey of Modern Physics—*By G. F. Hull, Macmillan Co., 457 p, $3.50, 1936.*

Atomic Theory—*By Arthur Haas, D. Van Nostrand Co., 272 p, $6.00.*

Fundamentals and consequences of modern atomic theory. Higher mathematics avoided.

Matter, Electricity, Energy—*By Walter Gerlach, D. Van Nostrand Co., 422 p, $6.00 1928.*

A scientific treatment of atomtic fundamentals presented without technical mathematics.

Introduction to Theoretical Physics—*By Leigh Page, D. Van Nostrand Co., 661 p, $6.50, 1928.*

A graduate or senior text for students majoring in physics, and dealing with dynamics, hydrodynamics, thermodynamics, electromagnetism, and optics and spectroscopy.

Introduction to Theoretical Physics—*By Arthur Haas, D. Van Nostrand Co., Vol. I, 346 p, $7.50, Vol. II, 492 p, $7.50.*

Procedures in Experimental Physics—*By John Strong, Prentice-Hall, $6.70.*

Describes modern techniques, apparatus, and procedures used in experimental physics.

Glass, The Miracle Maker—*By C. J. Phillips, Pitman Publishing Corp., 425 p, $4.50.*

A book on glass for the engineer, designer, student, and executive, as well as for the general reader.

The Properties of Glass—*By George W. Morey, Reinhold Publishing Corp.*

Acoustics & Sound

Acoustics—*By Alexander Wood, Interscience Publishing Co., 575 p, $7.00, 1941.*

Acoustics and Architecture—*By P. E. Sabine, McGraw-Hill Book Co., 327 p, $3.50. 1932*

Treatise of the behavior of sound in buildings, with special emphasis on recent developments. Theory and applications are given.

The Acoustics of Buildings—*By F. R. Watson, John Wiley & Sons, 155 p, $3.00, 1941.*

Gathers together in convenient form recent scientific results on this subject.

Applied Acoustics—*By Harry F. Olson and Frank Massa, P. Blakiston Sons & Co., 494 p, $5.50, 2nd ed., 1939.*

A practical guide to the design, construction and operation and analysis of acoustic and electro-acoustic devices.

Architectural Acoustics—*By Vern Knudson, John Wiley & Sons, 617 p, $6.50, 1932.*

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Elements of Acoustical Engineering—*By Harry F. Olson, D. Van Nostrand Co., 344 p, $6.00, 1940.*

Treatment of acoustical principles and their applications; college level.

A Textbook of Sound—*By Edwin H. Barton, Macmillan, $5.00, 2nd ed., 1908.*

Theory of Vibrating Systems and Sound—*By I. B. Crandall, D. Van Nostrand Co., 282 p, $5.00, 1926.*

Treatment of the basic theory of vibrating systems and sound.

Vibration and Sound—*By P. M. Morse, McGraw-Hill Book Co., 350 p, $4.00, 1936.*

Textbok on the theory of vibrations and sound for students of physics and communication engineering.

Speech and Hearing—*By Harvey Fletcher, D. Van Nostrand Co., 331 p, $5.50, 1929.*

An investigation of the psychological factors involved in speech and hearing, particularly with reference to communication systems.

Science and Music—*By Sir James Jeans, Macmillan Co., 258 p, $2.75, 1937.*

Ultrasonics and Their Scientific and Technical Applications—*By Ludwig Bergman and translated by H. S. Hatfield, 364 p, $4.00, 1939.*

Experimental results receive the main emphasis; theoretical work is presented only when it is necessary for proper understanding of the subject.

Theory of Sound—*By Lord Rayleigh, Robert W. Strutt, Macmillan Co., Vol. I, 480 p, $5.00. Vol. II, 504 p, $5.00.*

Modern Acoustics—*By A. H. Davis, Macmillan Co., 345 p, $7.00, 1934.*

Dynamical Theory of Sound—*By Horace Lamb, Longmans, Green and Co., 303 p, $6.50, 2nd ed., 1925.*

Motion Picture and Sound Engineering—*By F. Albin, L. E. Clark, A. P. Hill, J. K. Hilliard, H. Kimball, K. Lambert, and W. Miller, D. Van Nostrand Co., 547 p, $6.50, 1938.*

A comprehensive engineering discussion of the electrical, acoustic and photographic problems in motion pictures sound engineering.

Textbook of Sound—*By A. B. Wood, Macmillan Co., 519 p, $5.00, 1930.*

Sound—*By F. R. Watson, John Wiley and Sons, 219 p, $2.50, 1935.*

An elementary textbook, on the science of sound and phenomena of hearing.

Acoustics—*By Alexander Wood, Interscience Publishers, Inc., New York, N. Y., 575 p, 310 illus., $7.00, 1941.*

Acoustics—*By G. W. Stewart and R. B. Lindsay, D. Van Nostrand Co., 360 p, $5.00, 1931.*

Clear exposition of essential parts of the theory of acoustics, presented with modern applications uppermost in mind.

Introductory Acoustics—*By G. W. Stewart, D. Van Nostrand Co., 200 p, $2.75, 1933.*

Common phenomena of sound and acoustics treated broadly, without use of mathematics.

Sound, a Textbook—*By A. T. Jones, D. Van Nostrand, 450 p, $3.75, 1937.*

Emphasis is on fundamental principles and important acoustic phenomena.

Acoustics—*By Percy L. Marks, Chemical Publishing Co., 143 p, $3.00, 1941.*

Practical Acoustics and Planning Gains and Noise—*By Hope Bagenal, Chemical Publishing Co., 146 p, $2.50, 1942.*

Acoustic Design Charts—*By Frank Massa, P. Blakiston Co., 228 p, $4.00, 1942.*

IV PRINCIPLES OF ELECTRICITY

Alternating Current Circuits—*By R. M. Kerchner and G. F. Corcoran, John Wiley and Sons, 510 p, $4.75, 1938.*

A modern approach to a-c theory and practice.

Alternating Current Circuits—*By M. P. Weinbach, Macmillan Co., 417 p, $4.50, 1933.*

Treatment of circuit theory with emphasis on the fundamentals of power and communication circuits.

Circuits and Machines in Electrical Engineering—*By J. O. Kraehenbuehl and M. A. Faucett, John Wiley & Sons, 691 p, $4.50, 1938.*

Elementary treatment, suitable for use as first course for electrical engineering students.

Course in Electrical Engineering, Vol. I, Direct Currents—*By C. L. Dawes, McGraw-Hill Book Co., 751 p, $4.00, 3rd ed., 1937.*

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Course in Electrical Engineering, Vol. II, Alternating Currents—*By C. L. Dawes, McGraw-Hill Book Co., 750 p, $4.00, 1938.*

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Emphasizes the principles of electric circuit theory. Mathematics reduced to simple form.

Electrical Engineering Fundamentals—*By G. F. Corcoran and E. B. Kurtz, John Wiley & Sons, 450 p, $4.00, 1941.*

Provides electrical engineer with background necessary for advanced study in this field.

Electrical Circuits and Machinery—*By F. W. Hehre and G. T. Harness, John Wiley & Sons, 513 p, $4.50 for Vol. I, 635 p, $6.00 for Vol. II.*

Vol. I designed as general textbook for non-electrical students or introduction for ee students. Covers d-c.

Vol. II deals with a-c. Two chapters devoted to electronics.

Electric Circuits—*By E.E. Staff of M.T.T., John Wiley and Sons, 782 p, $7.50.*

A comprehensive treatment of linear circuit phenomena with some discussion of nonlinear circuits.

Electrical Fundamentals—*Technical Manual TM 1-455, War Department, Washington, D. C., Superintendent of Documents, Washington, D. C., 155 p, $0.25, 1941.*

A manual of basic electrical phenomena for radio electricians and operators and service men.

Electrodynamics—*By Leigh Page and N. I. Adams, D. Van Nostrand, 506 p, $6.50, 1940.*

Advanced text in the theoretical aspects of electrodynamics. Begins with three dimensional vector analysis.

Electromagnetic Devices—*By H. C. Roters, John Wiley and Sons, 561 p, $6.00, 1941.*

Graduate textbook and reference work for those concerned with relays, and similar magnetic devices. Knowledge of electrical engineering is assumed.

Elements of Electrical Engineering—*By Arthur L. Cook, John Wiley & Sons, 622 p, $4.00, 1941.*

A short course written to fit all students of enginering for future work in their profession.

Engineering Electricity—*By R. G. Hudson, John Wiley & Sons, 284 p, $3.00, 1941.*

Concise exposition of principles and applications of electricity and magnetism for technical students not specializing in electrical engineering.

Electric and Magnetic Fields—*By Stephen S. Atwood, John Wiley & Sons, 430 p, $4.50, 2nd ed., 1941.*

General introductory course in electricity and magnetisers as basis for more advanced courses in design.

Electric Circuit Analysis—*By M. G. Malti, John Wiley and Sons, 389 p, $4.50, 1939.*

Thorough treatment of principles and laws of electric circuits.

Elements of Electricity—*By Wm. H. Timbie, John Wiley and Sons, 569 p, $3.00, 1937.*

Fundamental data on electricity with which vocational school students should be familiar.

Essentials of Electricity—*By William H. Timbie, John Wiley and Sons, 306 p, $2.00, 1931.*

Facts and laws of good electrical practice for students and workmen.

Essentials of Alternating Currents—*By W. H. Timbie and H. H. Higbie, John Wiley and Sons, 377 p, $2.25, 2nd ed., 1939.*

Contains only that material essential to a worker on a-c appliances.

Electrical Engineering—*By C. V. Christie, McGraw-Hill Book Co., 717 p, $5.00.*

Standard text for junior and senior electrical engineering students, emphasizing power and machinery.

Fundamentals of Electricity and Electromagnetism—*By V. A. Suydam, D. Van Nostrand Co., 690 p, $4.75.*

College text designed to provide broad comprehensive understanding of electrical technology.

Industrial Electricity; Direct Current Practice—*By Wm. H. Timbie, John Wiley and Sons, 635 p, $3.00, 1939.*

Important principles of electricity as applied to modern industry.

Introductory Electrodynamics for Engineers—*By Edward Bennett and H. M. Crothers, McGraw-Hill Book Co., 655 p, $4.50, 1926.*

A development of the theory and electrical principles which are fundamental to the design and technical supervision in the electrical field.

Introduction to Electrical Engineering—*By George V. Mueller, McGraw-Hill Book Co., 306 p, $2.75.*

Transient and steady state treatment of electric, magnetic, and dielectric circuits.

Magnetic Circuits and Transformers—*By E. E. Staff of M.I.T., John Wiley & Sons, In Press.*

Principles of Electricity and Electromagnetism—*By G. P. Harnwell, McGraw-Hill Book Co., 619 p, $5.00, 1938.*

Introduction to experimental and theoretical electricity from point of view of physicist with greater emphasis on experimental aspects. Sound training in electricity and physics a prerequisite, as given in first 3 years of most colleges.

Principles of Electrical Engineering—*By W. H. Timbie and V. Bush, John Wiley and Sons, 546 p, 3rd ed., $4.50.*

A well known text for beginning electrical engineering students.

Principles of Electric Power Transmission—*By L. F. Woodruff, John Wiley and Sons, 257 p, $3.50, 2nd ed.*

Fundamentals principles of power transmission and methods whereby they are made applicable to practical engineering problems.

Principles of Alternating Currents—*By R. R. Lawrence, McGraw-Hill Book Co., 457 p, $4.00, 1935.*

A well known college text on principles of a-c.

Principles of Alternating Current Machinery—*By R. R. Lawrence, McGraw-Hill Co., 614 p, $5.50, 3rd ed., 1940.*

A standard college text treating transformers and rotating a-d machinery.

Principles and Practice of Electrical Engineering—*By A. Gray and G. A. Wallace, McGraw-Hill Book Co., 586 p, $4.00, 5th ed., 1940.*

For those requiring good knowledge of electricity but who are not specializing in electrical engineering.

Principles of Electrical Engineering—*By Grover C. Blalock, McGraw-Hill Book Co., 584 p, $4.00, 2nd ed., 1936.*

Concise presentation of fundamental principles, with reference to practical applications for technical students.

Static and Dynamic Electricity—*By W. R. Smythe, McGraw-Hill Book Co., 560 p, $6.00, 1939.*

Formulates basic laws of electrostatics, magnetostatics and electromagnetic theory by concise vector methods from underlying experimental facts.

Electric Circuits and Machinery—*By F. W. Hehre and G. T. Harness, John Wiley and Sons, Vol. I, 513 p, $4.50, 1940. Vol. II, $6.00, 1942.*

General textbook for non-electrical engineering students and as introductory text for electrical engineering students.

Mathematical Theory of Electricity and Magnetism—*By Sir James Jeans, Macmillan Co. 587 p, $4.85, 1925.*

Fundamentals of Electromagnetism—*By Geoffrey Cullwick, Macmillan Co. 352 p, $3.75, 1939.*

Modern Magnetism—*By L. F. Bates, Macmillan Co., 340 p, $4.00, 1939.*

Electricity and Magnetism—*By C. A. Culver, Macmillan Co., 383 p, $3.50, 1930.*

Electricity and Magnetism; Theory and Application—*By N. E. Gilbert, Macmillan Co., 585 p, $4.50, 1941.*

Electrical Engineering—*By L. A. Hazeltine, Macmillan Co., 625 p, $6.50, 1924.*

Principles of Electricity—*By Leigh Page and N. I. Adams, D. Van Nostrand Co., 630 p, $4.25, 1931.*

Text suitable for undergraduates who have completed physics and calculus and for advanced students wishing more comprehensive training in electromagnetism.

Electricity; A Study of First Principles—*By Elmer E. Burns, D. Van Nostrand Co., 235 p, $1.75, 1930.*

Alternating Currents for Technical Students *By Calvin C. Bishop, D. Van Nostrand Co., 317 p, $2.00, 1930.*

Insulation of Electrical Apparatus—*By Douglas F. Miner, McGraw-Hill Book Co., 306 p, $5.00, 1941.*

Discussion of insulation problems for designer and user of electrical apparatus.

Traveling Waves on Transmission System—*By L. V. Bewley, John Wiley and Sons, 334 p, $4.50, 1933.*

Convenient reference and textbok for advanced courses in engineering.

Transients in Linear Systems—*By M. F. Gardner and J. L. Barnes, John Wiley and Sons, 389 p, $5.00, 1942.*

Rigorous yet simple treatment of linear physical systems.

High Voltage Cables—*By L. Emanuell, John Wiley and Sons, 107 p, $2.50, 1930.*

Discussion of high voltage cable technology, test and applications.

Electric Circuit and Machine Experiments—*By F. W. Hehre and J. A. Balmsford, John Wiley & Sons, 278 p, $3.00.*

Eighty-four experiments covering laboratory course for college work.

V. ELECTRICAL & RADIO MEASUREMENTS

Alternating Current Bridge Methods—*By B. Hague, Pitman Pub. Corp., 587 p, $8.50, 4th ed., 1938.*

A comprehensive treatment of measurements by means of bridge circuits. A reference work for engineers.

Electrical Engineering Experiments; Theory and Practice—*By H. R. Reed and G. F. Corcoran, John Wiley and Sons, 500 p, $4.50, 1939.*

Elementary instruction in electrical engineering laboratory methods, for technical students.

Electrical Laboratory Experiments—*By B. C. Dennison, John Wiley and Sons, 487 p, $4.00, 1936.*

Comprehensive laboratory textbook for engineering students.

Electrical Measurements—*By F. A. Laws, McGraw-Hill Book Co., 739 p, $6.00, 2nd ed., 1938.*

A complete discussion of electrical measuring methods and principles primarily at audio frequencies.

Electrical Measurements and Measuring Instruments—*By E. W. Golding, Pitman Publishing Corp., 828 p, $7.50, 1940.*

Principles of Electric and Magnetic Measurements—*By P. Vigoreaux and C. E. Webb, Prentice-Hall Inc., 392 p, $5.00, 1936.*

Discusses all types of instruments, both electrical and magnetic and outlines tests and experiments that can be conducted through their use.

Commercial A-C Measurements—*By G. W. Stubbings, D. Van Nostrand Co., 348 p, $6.00, 2nd ed., rev., 1937.*

Comprehensive account of theoretical electricity and practical construction of electric measuring instruments.

Advanced Electrical Measurement—*By W. C. Michels, D. Van Nostrand Co., 347 p, $3.50, 2nd ed., 1941.*

Comprehensive textbook covering fully all electrical measurements, standard methods and apparatus used in the laboratory.

The Measurement of Inductance, Capacitance and Frequency—*By Albert Campbell & E. C. Child, D. Van Nostrand Co., 488 p, $12.00, 1935.*

Complete and authoritative work, explaining theory, how theory is applied to each type of instrument and applications of electrical measurements to many measuring problems.

Experimental Radio Engineering—*By J. H. Morecroft, John Wiley & Sons, 345 p, $3.50, 1931.*

51 experiments covering the entire range of radio circuit theory.

Radio Frequency Measurements by Bridge and Resonance Methods—*By L. Hartshorn, Chapman, 280 p, 21 s.*

Theory and Practice of Radio Frequency Measurements—*By E. B. Moullin, Lippincott, 487 p, $12.50, 1931.*

Radio Frequency Electrical Measurements—*By H. A. Brown, McGraw-Hill Book Co., 383 p, $4.00, 1938.*

Laboratory measurements text for seniors and engineers.

Measurements in Radio Engineering—*By F. E. Terman, McGraw-Hill Book Co., 400 p, $4.00, 2nd ed., 1945.*

Engineering discussion of measurement problems commonly encountered by radio engineers.

High Frequency Measurements—*By August Hund, McGraw-Hill Book Co., 491 p, $5.00, 1933.*

Measurement methods and systems covering a wide range of frequencies. A reference work with many bibliographical references.

A Course in Radio Fundamentals—*By George Grammer, American Radio Relay League, West Hartford, Conn., 104 p, $0.50, 1942.*

Elementary laboratory experiments for those with little equipment who must study by themselves. Vocational or high school level.

Cathode Ray Oscillography—*By J. T. MacGregor-Morris and J. A. Henley, Instruments Publishing Co., 249 p, $6.00, 1936.*

Guide to Cathode Ray Tube Patterns—*By Merwyn Bly, John Wiley and Sons, 30 p, $1.50, 1943.*

A summary, largely pictorial, of cathode-ray tube patterns encountered in the usual course of laboratory and test bench work.

Radio Data Sheets—*By R. T. Beatty, Electronics Laboratories, Indianapolis.*

Thirty alignment charts for the design of more important radio circuits and components by means of straight edge engineering.

Cathode Ray Tubes—*By Manfred Von Ardenne, Pitman Pub. Corp., 530 p, $14.00, 1939.*

Cathode Ray Tube—*By G. Parr, Chapman, 188 p, 13s 6d, 1942.*

Applications of the Cathode Ray Oscillograph in Radio Research—*By Watt, Watson and Herd, Harrison and Sons, Ltd.*

Cathode Ray Oscillograph—*By J. H. Reyner, Pitman Publishing Corp., 177 p, $3.40, 1940.*

A-C Calculation Charts—*By R. Lorenzen, John F. Rider Publishers, 160 p, 146 charts, $7.50, 1942.*

A series of reactance-frequency-capacitance-inductance charts for circuit design.

(To be continued)

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Fluorescent Lamps Show Standing Waves on Lines

By P. M. HONNELL

THE USE OF A RAREFIED gas tube (such as neon) to demonstrate the presence of high-frequency standing waves on Lecher wires is not entirely satisfactory from the standpoint of visibility, especially when demonstrating these effects to large audiences. By utilizing fluorescent lamps in place of neon tubes, however, striking and spectacular displays which are clearly visible to a group consisting of as many as five hundred people can easily be secured.

This application is made possible by the fact that fluorescent lamps become luminous when placed in a high-frequency field, due to the so-called "inductive" ionization of the mercury vapor with resultant activation of the phosphor coating of the lamp. Since the ionization and resulting lamp luminosity are roughly proportional to the electric field intensity in which the lamp is placed, a better terminology for this phenomenon might be "capacitive ionization" or "electric field ionization."

Waves on Lecher Wires

Standing potential waves along an energized Lecher wire system (or transmission line) can be made clearly evident by holding a fluorescent lamp at right angles to the line. As the lamp (maintained constantly at right angles to the line) is moved along the length of the line, maxima and minima of the potential wave are strikingly shown. At potential antinodes the fluorescent lamp glows brilliantly; at potential nodes the fluorescent lamp is extinguished.

In Fig. 1 the vertical lines indicate the potential wave distribution symbolically. It should be noted that the fluorescent lamp becomes luminous only over that portion of its length immediately adjacent to the Lecher wires (where the field intensity is a maximum), in contrast to the usual full-length brilliancy of such lamps when utilized for illumination.

Waves on Loaded Lines

Standing waves on uniformly loaded lines (having impedance uniformly distributed along their length) exhibit shorter physical lengths for a given frequency than do non-loaded conductors.

A typical form of loaded conductor is a long thin solenoid. This phenomenon is nicely demonstrated by placing a spaced-turn winding on the fluorescent lamps themselves, thereby making them the cores of the solenoids. A loaded line of this character is shown in Fig. 2, with the standing potential wave distribution again shown by the vertical lines.

When the loaded line is energized at the proper frequencies to obtain pronounced standing waves, the fluorescent lamps glow with alternately bright and dark bands, indicating voltage anti-nodes and nodes respectively. The distance between nodes (or anti-nodes) is one-half wavelength, and is much less than the free-space length.

Voltage Distribution Along Antenna

Another striking demonstration shows the voltage distribution over a half-wave antenna. Such an antenna, driven by means of an oscillator (either directly or through the medium of an unbalanced Lecher wire feeder system, for example), will have a potential gradient along its length approximately as shown by the dotted curve in Fig. 3. Voltage maxima exist at each end, with a voltage minimum at the center.

A half-wave antenna operated at 125 mc will have a length of about

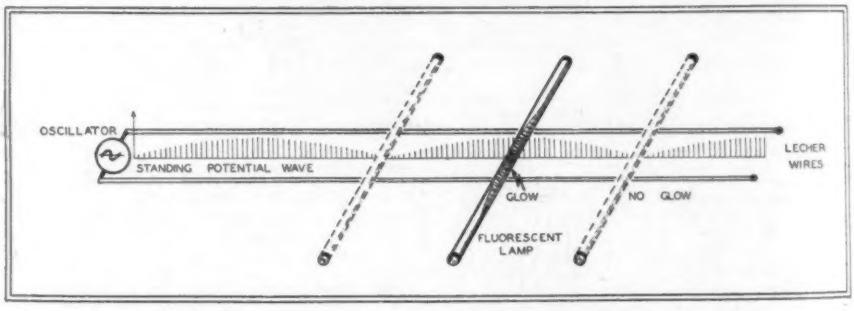

Fig. 1—Demonstration of standing waves on Lecher wires by means of fluorescent lamps held at right angles to the high-frequency system

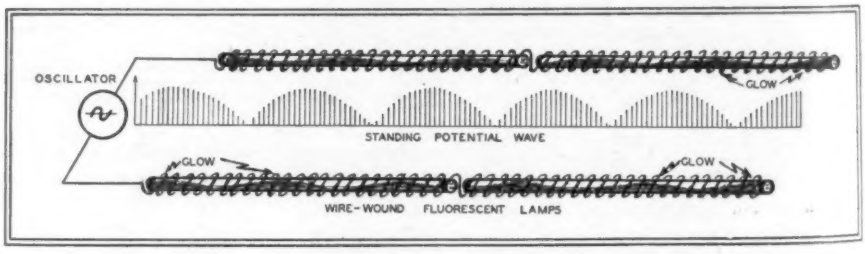

Fig. 2—By winding coils loosely upon the fluorescent lamps, the standing waves appearing on loaded lines may be demonstrated

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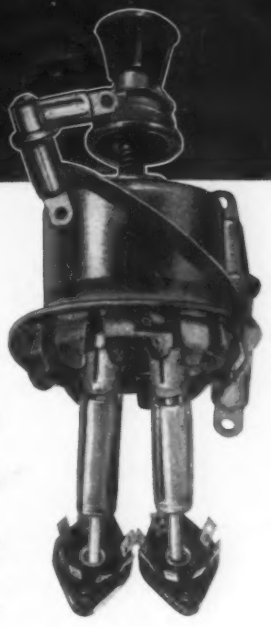

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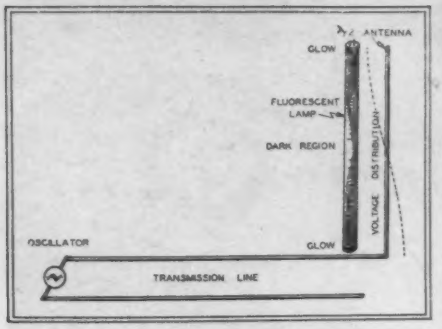


Fig. 3—The potential gradient along a 125-Mc half-wave antenna may be readily studied with a fluorescent lamp

48 inches. This is also the exact length of the 40 watt, T-12 type of fluorescent lamp. Thus, by placing a lamp of this type some two inches from the antenna and parallel thereto, the potential distribution of Fig. 3 will be clearly depicted when the oscillator frequency is correct. A dark region will exist at the center of the lamp and both extremities will be brilliantly luminescent, indicating the voltage node and antinode respectively.

Practical Notes

Although a fluorescent lamp with a burned-out filament is ordinarily useless for illumination purposes, it is perfectly satisfactory for these demonstrations since no electrical connections are made to the lamp. As in all experiments of this kind, best results are obtained when the lamp is supported by insulators because the presence of the hands on the lamp often introduces an extraneous coupling and false glow.

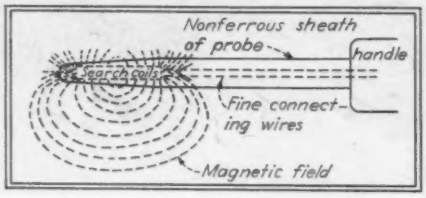
As is well known, the temperature of the bulb has some effect on the ease of ionization of the mercury vapor in the lamp. If some difficulty is experienced in getting the lamp to strike in regions of low potential gradient, it is helpful to warm the bulb first by ionizing it in regions of strong potential gradients (such as at a voltage maximum along the transmission line, or near the oscillator tank circuit). The lamp will then strike easily.

NOTE: Safety precautions must be kept in mind. In particular, keep the high-voltage B supply of the oscillator or amplifier out of the transmission-line or Lecher wire circuits by using inductive or capacitive coupling if the fluorescent lamp is to be held in the hands of the lecturer.

Surgical Applications for Electronic Metal Locator

COMMERCIAL DEVELOPMENT of the experimental metal locator so dramatically used on Pearl Harbor victims has resulted in an electronic instrument sensitive enough to locate an ordinary steel needle at a depth of more than 1½ inches. In use it has actually located a nonferrous metal fragment less than ¼ inch in diameter lodged underneath the Achilles tendon in the foot of a bombing victim. Locators "on call" at the factory (Waugh Laboratories, 420 Lexington Ave., New York City) have been used frequently in New York City hospitals for emergency operations.

The operation of the production model is essentially the same as that of the experimental device. The circuits are adjusted for zero meter reading with no extraneous metal in the magnetic field of the search probe.



The magnetic field produced by the search coils in the probe used for locating metal fragments has an effective range of several inches

The probe contains tiny search coils which produce a magnetic field essentially as indicated in the diagram. Any metal, ferrous or nonferrous, in this magnetic field will upset the initial balance of the circuit and give a meter indication.

When the probe is brought near a metal particle, the meter pointer moves up, and reaches a maximum when the probe is closest to the metal object. One probe being used is about the thickness of a fountain pen, with a handle containing a sensitivity adjustment. Another design employs one large probe for external searches, and a smaller probe which can more readily be inserted in a small wound or in the primary incision to verify results of intial searching of the suspected area.

Metal instruments must be removed from the wound during this search, hence blood vessels must be tied off and clamps removed, and wood or plastic retractors used. The probe, including its handle and a part of the connecting cable, may be rendered sterile for probing inside wounds by placing it in a fitted rubber sleeve previously sterilized.

Since the meter reading of the device depends both on size and distance of the metal object from the probe, depth estimates are not always possible with the locator alone. If an x-ray negative is available, however, the depth can be estimated by selecting a piece of metal of the same composition and the approximate dimensions of the metal shown on the x-ray film, and moving the probe toward this test specimen until the meter reading is the same as that previously noted at the surface location on the patient's body. The distance between the probe and the test specimen is then the depth of the imbedded object.

The new model is the size of a portable radio receiver, weighs about 20 pounds, requires only plugging into a 115-volt, 60-cycle outlet and connecting a ground wire to a water pipe (to prevent accumulation of static and possible sparking), and can also be operated from an auto storage battery through a 100-watt a-c inverter.

Photoelectric Scale Measures Oil Consumption of Engines

CONSUMPTION RATES of fuel oil and lubricating oil for internal combustion engines can be measured automatically and accurately by adding a light source, optical system, photocell, relay and a pair of adjustable interceptor flags to a standard platform scale on which the fuel tank is placed.

One flag is set at the scale reading, and the other is set below this reading by an amount equal to the quantity of oil or fuel for which the test is to be run. The light beam system is then set at the lower flag, in such a way that the scale pointer intercepts the light beam at the end of the run. The photoelectric system can be connected to sound an alarm bell, stop a time clock, or indicate in some other way how long it took the engine to consume the quantity of oil corresponding to the interval between the flags. Photoelectric scales utilizing this principle have been developed by The Kron Co., Bridgeport, Conn.

CHAINED... FOR SAFETY

From the time of their earliest use in hospital operating rooms, the handling of most inhalation agents has been fraught with danger of fire or explosion from static sparks. However, this risk did not receive serious recognition until recent years when accepted engineering principles were applied to this aspect of anesthesia and surgery.

With the introduction of cyclopropane and other newer types of gases, further attention was focused on the elimination of this hazard. How could the electrical potentials of the anesthetists, the patient and the apparatus be equalized to eliminate the possibility of spark?

The answer was found in fastening the group together by means of silver chains and other conductive materials. Connected into the circuit, a device consisting of high resistances prevents the formation of a static charge of any important degree of intensity.

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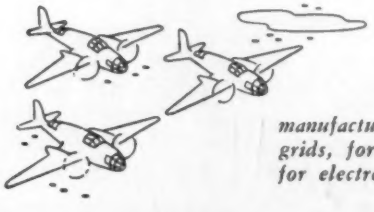

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Two New Invar Alloys for Electronic Devices

IN APPLICATIONS where the tendency of metals to expand with heat must be overcome or minimized, a 36 percent nickel alloy known as Invar has heretofore been extensively used. Application of this alloy to electronic products has long been limited by machining difficulties, however. This problem has now been overcome by The Carpenter Steel Company, Reading, Pa. with the development of a free-machining grade of Invar. The new property was secured by adding a small amount of selenium to the alloy, giving a new low-expansion alloy known to the trade as *Carpenter Free-Cut Invar "36"*.

Standard Invar alloys are nonmagnetic, but a special Invar-like magnetic alloy known as *Maginvar* has recently been developed by the General Electric Research Laboratory specifically for use in tuning forks.

• • •

Combustion Indicator Tests Diesel Engine Exhaust Smoke

THE CLEARNESS of the exhaust smoke from a diesel engine is a dependable indicator of the quality of combustion, but visual observations of the exhaust are at best inaccurate in daytime and are practically impossible to secure at night. The development by Photovolt Corp., New York City, of a smoke meter capable of registering smoke density from 0 to 20 percent by photoelectric means now makes it possible to monitor engine combustion accurately and even automatically if desired.

A typical smoke meter installation on a diesel engine is shown in Fig. 1,

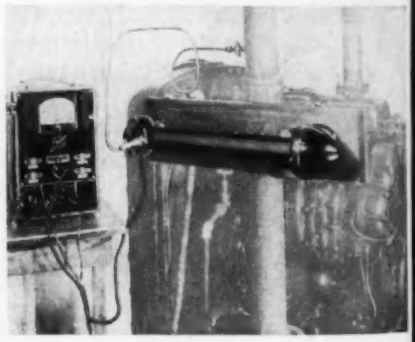
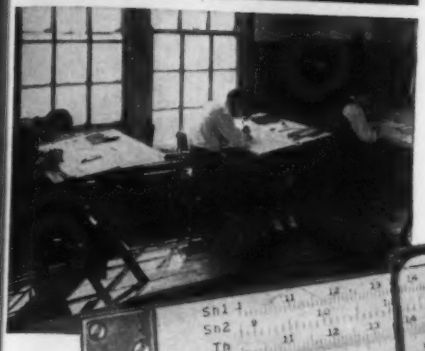
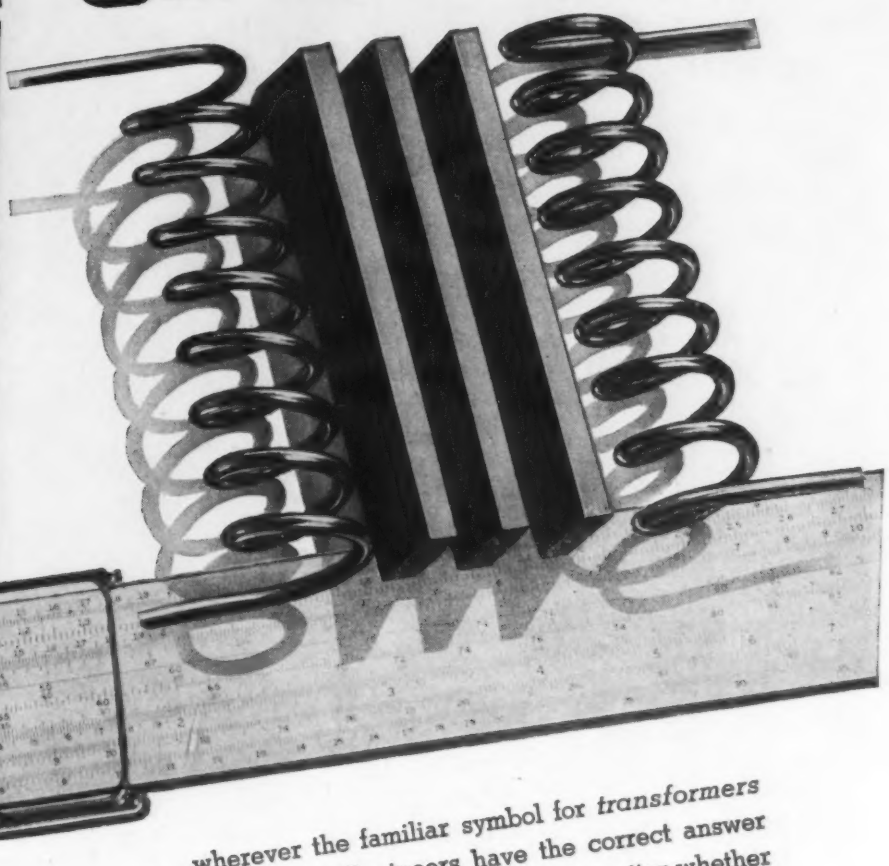


Fig. 1—Combustion efficiency of this diesel engine is indicated in terms of exhaust smoke density when a suction fan pulls part of the exhaust gas through a beam of light in an 18-inch tube mounted on the engine



One basic symbol....



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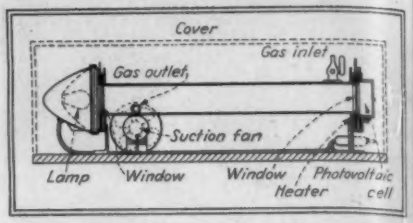

Fig. 2—Cross-section view of photoelectric unit which measures the density of almost invisible exhaust gases

and the operating principle is illustrated by the diagram in Fig. 2. The system is also applicable to oil burners, which have correspondingly low smoke densities under normal operation.

For this instrument, the percent smoke density has been defined as the percent reduction in light passing through an 18-inch column of exhaust gas. The exhaust gas enters at the upper right-hand petcock in Fig. 2, travels through the tube, and is pulled out by a suction fan through an outlet near the other end of the tube. Photovoltaic cell and light source are at opposite ends of the tube. The instrument is adjusted to give full scale deflection on the meter when clean air is in the tube, and the meter is calibrated to read smoke density in percent when the tube is filled with exhaust gas.

Glass windows are provided at the ends of the tube to protect the lamp and the photovoltaic cell from smoke particles. Windows are hinged for cleaning purposes; cleaning is necessary only when the instrument can no longer be adjusted to zero for clean air. The window on the inlet side carries a heating coil, to prevent moisture from condensing on the glass.

• • •

Animated Motion Picture Explains Telephoto Process

By LYNE S. METCALFE

A PICTORIAL PRESENTATION of the basic principles involved in sending wire-photos has recently been made available in the form of a one-reel sound motion picture film entitled "Spot News". It is produced by the Jam Handy Organization of Detroit, on 16-mm safety film.

The sound track on the film furnishes musical and sound background while the story is told with commentary and dialog. The film starts by showing a wire-photo crew photographing an airplane taking

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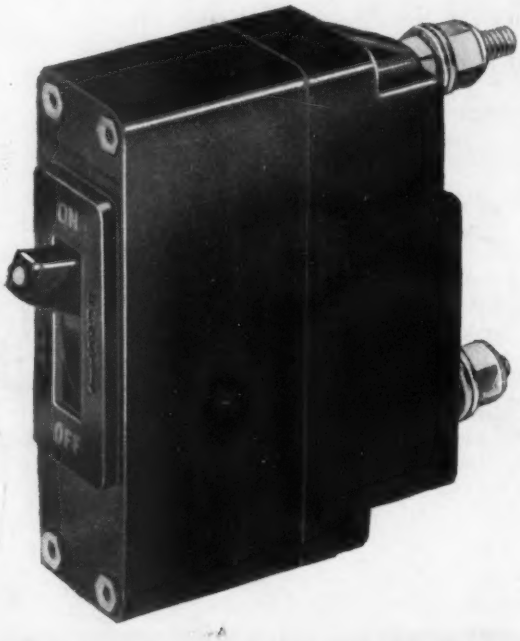
The MCM911, one of a series of quick-make and quick-break circuit breakers for 24-volt service with ratings from 180 amperes down to 60 amperes. Breakers 125 volts A.C. or D.C. are also available. They have a special trigger construction to prevent dust infiltration and can be obtained in either luminous or plain tip. Others are made for ratings down to 2 amperes.

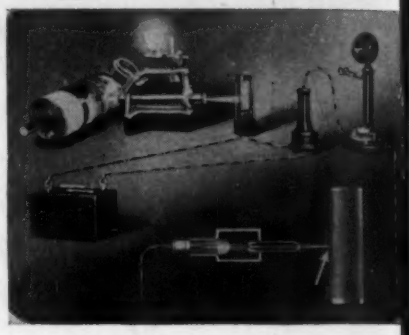


For further information and a copy of our Circuit Devices Catalog for Mobile Military Equipment, write Section P532-119, Appliance and Merchandise Department, General Electric Co., Bridgeport, Connecticut.

GENERAL ELECTRIC

off from the roof of a speeding automobile, then shows the picture being transmitted to the newspaper office over a telephone wire.

Various screen devices are used to simplify the explanations of what happens. For instance, the film shows a length of rope wound around a drum, with an ink picture painted on the wound-up rope. This rope is fed onto another drum to show how the picture will reappear thereon, as a simple analogy of the principle of sending photos by wire. Animated mechanical drawings are freely used.



Selected frames from the new 16-mm sound film "Spot News", which explains how a telephoto system works

The picture also shows an actual photograph being scanned by a photoelectric cell into lines which correspond to the length of rope shown in the model, for transmission as an electric current of varying intensity. Step by step in dramatic form it explains how the current arrives at the newspaper office is changed back into light values and is then printed as a picture in a modern newspaper plant.

An electronic system whose action is too complex to be seen even by watching the actual apparatus is thus made visible and understandable by means of technical animation.

Many other technical films have been produced. They portray com-

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TWO "KNOW HOWs" ARE BETTER THAN ONE

"Know how" proof #9...more each month

Your war production or post-war products will be as good as the "know how" (*and* the special or standard *fastenings*) you put into them. The products of your own "know how" will be even better if their standard or special fastening devices are the result of Scovill's many years of experience in Design and Production.

Scovill proves its Fastenings leadership with work, not words. The stud illustrated was made from copper wire by three cold forging operations, plus clipping, drilling, roll-threading. It is but one of the many jobs we have "engineered" into minimum metal—money—motions. And this same "know how" goes into the wide range of standard fastenings we offer.

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Mr. Reader: **please route this on to any others in your plant to whom our skill might be of help. Thank you!**

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plicated industrial operations with clearly understandable animated cross-section views showing mechanical, electrical or chemical actions which are normally not visible. By making entire jobs easy to understand, these educational or industrial training films help to speed learning and also reduce material and time losses by the worker who has "learned" but still does not "understand'.

• • •

Light-Beam Modulation by Photoelastic Effect in Glass

By WILLIS E. LECLAIR, Chief Engineer

Standard Coated Products Corp. Buchanan, N. Y.

THE TENDENCY OF GLASS or transparent plastic materials to become doubly refracting upon application of pressure is the basis for a new system of light modulation which is capable of handling large quantities of light, and requires only simple, easily constructed apparatus.

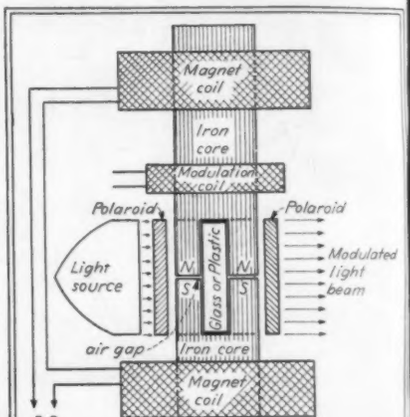

Fig. 1—Essential features of light modulator system utilizing the photoelastic effect in glass. Many other mechanical arrangements for the pressure-applying system are possible

The method of utilizing this photoelastic property of glass is shown in Fig. 1. Pressure is applied to the edges of the central plate of glass by squeezing it between the two-section iron core of an electromagnet. The amount of pressure is varied in accordance with the desired a-f modulation by feeding the output of an a-f amplifier to a modulation coil surrounding one section of the iron core. This coil produces flux alternately aiding and opposing the fixed flux of the magnet coils, thus varying the attractive force be-

Wish we could talk about some of this

The mid-western job, with photos, would make a honey of an ad. It's the largest high altitude test chamber in the country. Unusual specifications, too . . . Or the steel-saving, time-saving concrete altitude chamber that everybody said was impossible . . . And the small unit that brought a manufacturer's testing time on production runs down to 8% of his previous average . . .

Most of this information, if published, could be very helpful to manufacturers of equipment requiring Army or Navy high altitude and temperature tests. True, we are permitted to furnish government prime contractors with full particulars, when they ask for it. But *all* of them can't possibly know whether their special problems are within the scope of our activities . . . unless they write, and enable us to recommend solutions.

But, boy, will we have plenty to say to the entire field when the war is over and we can open our lab records!

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2. Apply to your purchase order the AA2X preference rating which you have received under the revision of War Production Board order P-133 dated February 4, 1943, part 3037.

3. In ordering replacement parts or equipment renewals give your distributor the serial number of the equipment to be repaired or replaced and the part number as shown in your instruction book. Apply the AA2X priority to your order.

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World's Largest Manufacturers of Instantaneous Sound Recording Equipment and Discs

tween the ends of the core at the ai gap.

Polarized Light Is Used

The beam produced by the ligh source passes first through a Pola roid lens (called the "polarizer" which polarizes the beam at an an gle of 45 deg. to the longitudina axis of the iron core. The resultin beam passes through cylindrica holes in the iron core and through the glass in the center of the core After emerging from the core, th beam passes through another Po laroid lens (called the "analyzer") which is set at 90 deg. to the firs polarizer and hence blocks the beam completely if the glass is omitted o is not under pressure.

At zero pressure, then, no ligh passes through the modulator unit As pressure is applied, the glass firs changes the plane polarized light t an elliptically polarized light with the major axis in the plane of the polarizer. As pressure is further increased, the ellipse in effect changes gradually from a long narrow shape to a circular shape, so that at a particular pressure the light is circularly polarized. Further increases in pressure give elliptic polarization again, but with the major axis now in the plane of the analyzer. Finally, this ellipse is i effect flattened so that at maximum pressure the light is plane polarized in the plane of the analyzer, and maximum light is transmitted by the modulator unit.

This highly useful change in the nature of light leaving the glass oc curs because the indexes of refrac tion for the regular and extraordin ary paths through the glass chang with pressure, causing a phase dif ference between light of the two paths. In effect, then, the glass acts as a shutter capable of varying the strength of the light beam grad ually from zero to maximum. The variation in light output is linear over a considerable range of a-f in put current, as indicated by the response curve in Fig. 2, and the constant pressure due to the magnet coils can be adjusted to place the operating point in the center of this linear region.

If the pressure applied to the glass is varied at an audio frequency and is within the elastic limits of the glass, the light leaving the system will vary in intensity at the same

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There's a break in the power line . . . and Jack Robinson is lost in the acres of machinery.

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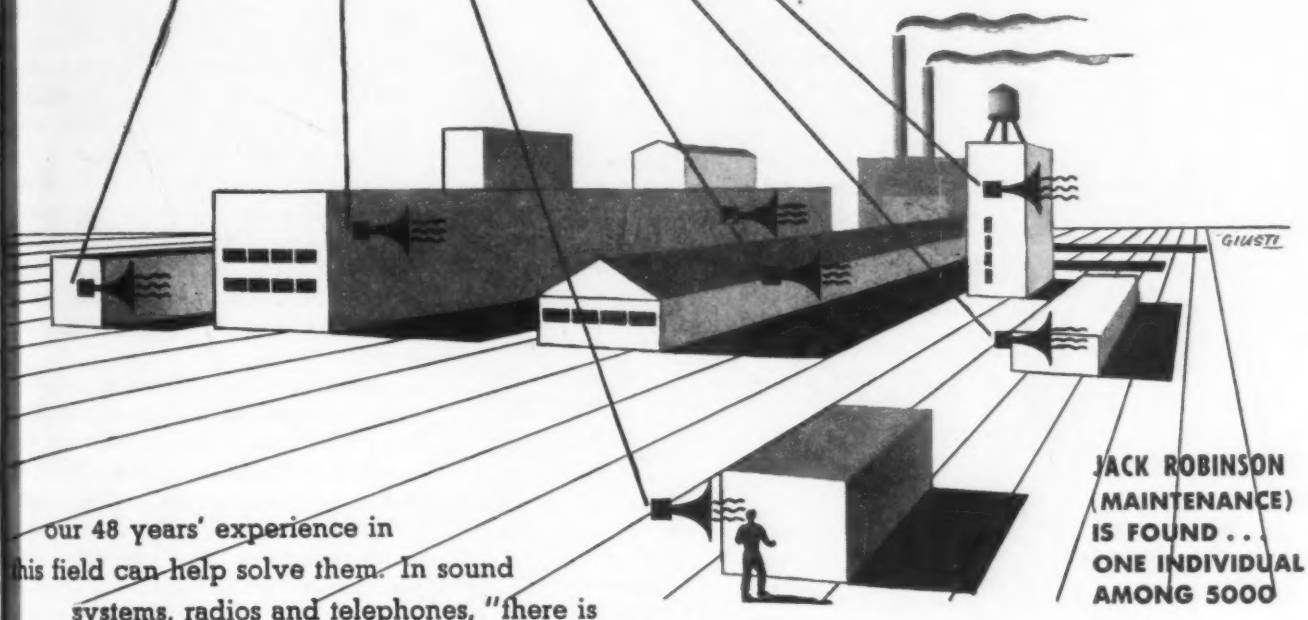
If your factory or plant has any communications problems whatever . . . our 48 years' experience in this field can help solve them. In sound systems, radios and telephones, "there is nothing finer than a Stromberg-Carlson." Why not get in touch with the Sound Systems Division of the Stromberg-Carlson Company, 100 Carlson Road, Rochester, New York. Write for free booklet No. 1930.



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Out of the fiery crucible of war will come new devices that will amaze the world . . . radio sets that are revolutionary . . . electronic equipment that will create new standards of living. The battlefronts of the world are the proving grounds for these new developments.

Sentinel, pioneer builder of receiving sets since the birth of the radio industry is right in the thick of the battle . . . producing equipment exclusively for the use of our fighting forces—equipment that is meeting the rigorous standards of our Army and Navy. Equipment that is given the acid test of war and is coming through with flying colors.

Meanwhile we can't plan the time of the war's end—But we can plan what Sentinel's going to do and what the new Sentinel Radio is going to be like. This much we can say now: There will be new Sentinels that will surpass every present radio . . . Electronic devices that will stagger the public's imagination . . . Merchandise that promises a new era of prosperity for Sentinel Dealers.

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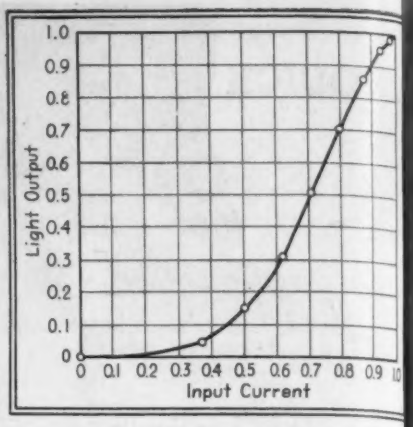

Fig. 2—Computed response curve for LeClair light modulator

audio frequencies. One factor limiting the amount of light which can be handled is the safe operating temperature of the Polaroid lenses, but here air cooling can greatly increase the handling capacity.

Relation Between Light Intensity and Coil Current

The formula for the angle of lag between the ordinary and extraordinary beams in the glass is $C(Y - Z)t$, where Y and Z are vertical and horizontal stresses, C is a constant for the glass and t is its thickness. Since C and t are constants and Z is zero, this simplifies to KY.

The force between the poles of a magnet is proportional to the product of pole strength divided by the square of the gap distance. Since the gap distance is substantially constant, the force is $Y = K_1 \phi^2$, where ϕ is the flux.

Assuming that operation is on a linear magnetization curve, the flux is proportional to the coil current, or $\phi = K_2 i$. Therefore, $Y = K_1(K_2 i)^2 = K_3 i^2$.

The intensity of light in terms of unity polarized light leaving the second polaroid is $I = \sin^2 Y/2$ when the Polaroids are crossed and at 45 deg. to the planes of the beams leaving the glass. The intensity may then be written as $I = \sin^2 K_3 i^2/2$ in terms of coil current. Assuming $K_3/2 = 1$ and i^2 varies from 0 to 2π, the curve shown in Fig. 2 is a plot of the response of the device.

The frequency response of the system is principally dependent upon the mechanical design and the material used in the pressure valve. A number of different plastics have been employed in place of the glass with good results.

RCA 849

R-F and A-F POWER AMPLIFIER, OSCILLATOR, MODULATOR

$120

LONGER LIFE

instead of increased ratings

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Today, it is long life that counts—not spectacular "peak" performance.

That is why, when the RCA-849 was materially improved over a year ago by use of the famous RCA zirconium-coated anode, you heard nothing about it—even after months of actual use had shown that the improvement was such as to warrant a substantial rating increase in normal times.

Instead of reflecting such an improvement in terms of higher tube ratings we utilized it to make conservative RCA tube ratings still more conservative. This program, we felt, was far more in keeping with the war effort because it assures longer life for tubes that are difficult to replace. This has been done, not only with the RCA-849, but with other RCA tubes as well.

The war has not stopped RCA engineering progress. It has only intensified it—a fact to which the thousands of hours of additional potential life now built in to many RCA Transmitting Tubes offer the most convincing proof.

RATINGS*
FILAMENT VOLTAGE, 11 VOLTS
FILAMENT CURRENT, 5 AMPERES

PLATE VOLTAGE, 2500 VOLTS, MAX.
PLATE DISSIPATION, 400 WATTS, MAX.
*For class C telegraph service.

HOW TO MAKE TUBES LAST LONGER ON THE JOB . . .

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There are many styles of "DP" connectors. Among them the "DP-D" for rack type equipment which covers a maximum of thirty contacts. In this unit there are insert arrangements for taking 10, 15 and 40 ampere contacts, and many variations are possible.

SEND FOR YOUR COPY OF CANNON BULLETIN ON "DP" CONNECTORS. This 24-page bulletin gives complete data, photographs and dimensions of the various "DP" connectors. Drop us a line on your letterhead and we'll gladly send you a copy. Address Department U, Cannon Electric Development Co., Los Angeles, Calif.

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REPRESENTATIVES IN PRINCIPAL CITIES — CONSULT YOUR LOCAL TELEPHONE BOOK

Modified Protective Gap for Transmitting Antennas

By ALVIN LEEMAN

Chief Engineer, Station WKBil

METERS AND OTHER EQUIPMENT in broadcast station are often damaged when heavy static charges collected by the antenna system discharge through the usual lightning protective gaps. This permits radio frequency energy from the transmitter to flow across the gap, causing heavy currents to flow through and damage meters and other delicate equipment. Static discharges cause trouble even in circuits designed so that damage cannot occur to equipment as r-f current will frequently continue to arc across the protective gaps until the carrier power is removed or the final power amplifier operation is upset to the extent that sufficient power is not available to continue the arc.

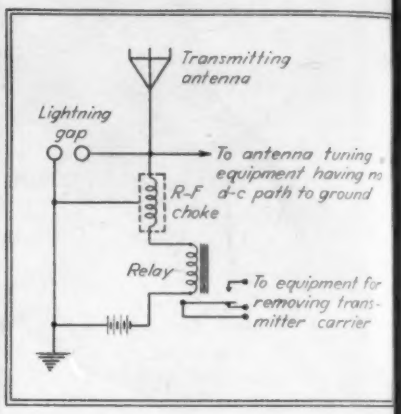
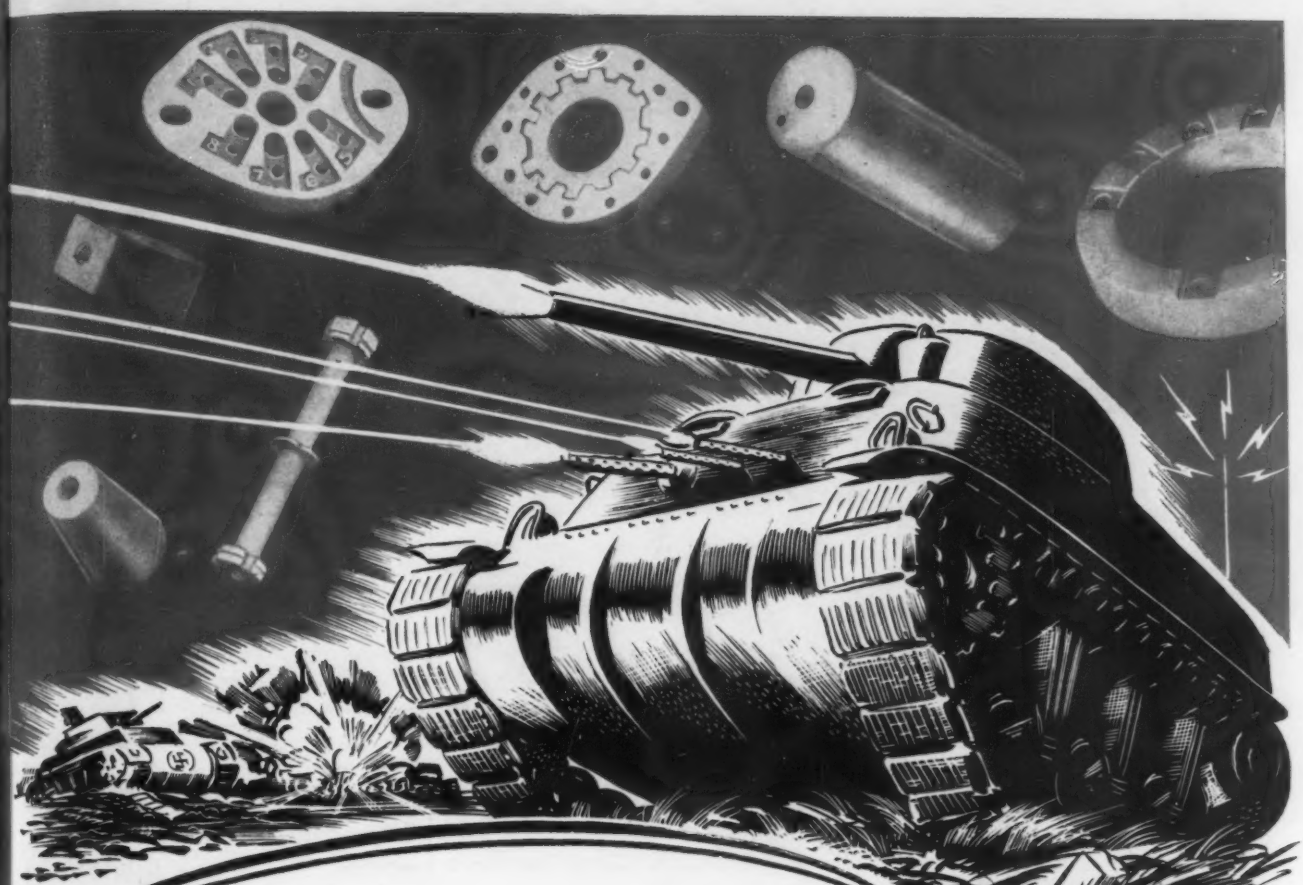


Fig. 1—Conventional method of removing carrier from transmitting antenna for the duration of a static discharge

In Fig. 1 is shown a system often used to remove the carrier for the duration of the static discharge. The carrier power is removed either by the application of a high bias in the buffer amplifier stage in low-level modulation systems, or by removal of final plate voltage when the high-level method is used. However, the circuit shown in Fig. 1 does not operate satisfactorily when there are induced currents in the antenna system from the tower lighting equipment, etc., as these currents will often cause the relay to operate and prevent the transmitter carrier from going on.

The circuit shown in Fig. 2 will eliminate trouble caused by induced currents because these currents cannot flow across the spark gap. Static



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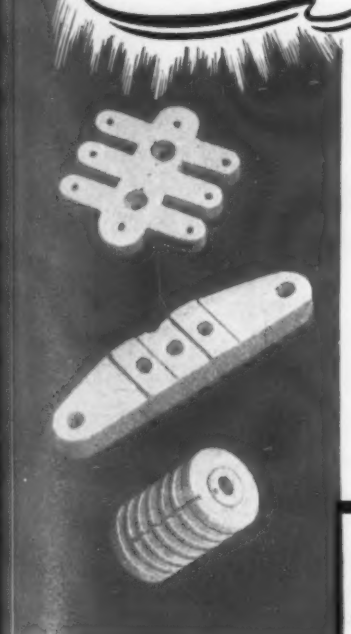
That is why you find more and more tank radios of the Allied Nations equipped with AlSiMag steatite ceramic insulators . . . . compact, tough, dependable.



ARMY E NAVY

AWARDED JULY 27, 1942

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AMERICAN LAVA CORPORATION

CHATTANOOGA, TENNESSEE

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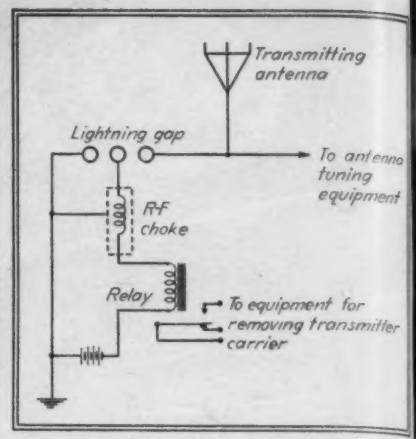

Fig. 2—Modified arrangement in which the carrier-interrupting relay is not affected by inducted currents of tower-lighting wires

charges will jump the gap and operate the relay in the required manner. This circuit may also be modified to operate in various other transmitter circuits to prevent flashovers, provided proper precautions are taken to limit the plate voltages going through the protective device to safe values.

• • •

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1616	Half-wave, high-vacuum rectifier	5.75
1625	25-watt, r.f. tetrode (12-v. heater)	3.50
1626	5-watt, triode oscillator	2.50
ET148	3.5-watt, a-b-f triode	2.25
VR105-30	Gaseous voltage regulator	1.25
VR150-30	Gaseous voltage regulator	1.25

OTHER POPULAR HYTRON TUBES*		
Type	Description†	Price
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2C45	7.5-watt, triode (modulator)	2.50
10Y	15-watt, general-purpose triode†	1.50
801A/801	20-watt, general-purpose triode†	2.50
HY61/807	25-watt, r.f. beam tetrode	3.50
841	15-watt, high-mu triode†	2.25
864	Non-microphonic voltage-amp. triode	1.00
HY24	2-watt, power triode†	1.50
HY31Z	30-watt, high-mu twin triode†	3.50
HY65	15-watt, r.f. beam tetrode†	3.00
HY69	40-watt, r.f. beam tetrode†	3.95
HY75	15-watt, a-b-f triode†	2.95
HY1148	(2C24) 1.8-watt, a-b-f triode†	2.25
HY615	3.5-watt, a-b-f triode†	2.25

*This is not a complete list. Wattage ratings indicate maximum plate dissipation.
†Instant-heating filament.
‡For complete characteristics consult Government specifications.

On this list of tubes which have recently joined the growing legions of Hytron types already marching on to Victory, you may find just the ones you want for your War equipments. Whether you choose the tiny "acorns" or the husky 1616 rectifier, you will discover the same high quality and design refinements which have made other Hytron tubes famous. If you place your orders well in advance, you will also be pleased by Hytron's on-schedule deliveries. Not too infrequently, deliveries are made from stock.

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FROM *Mica Headquarters*—

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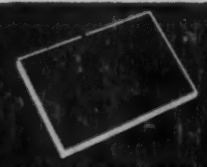

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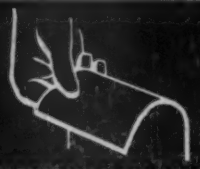

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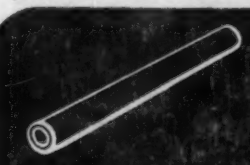
For insulating all types of coils. Made in several combinations. Recommendations furnished for specific operating conditions.



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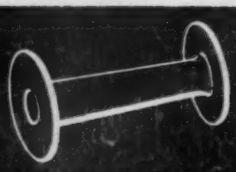

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Special shapes such as spools, troughs, flanges, bushings, discs, cones, furnished to specifications. Also molded over bars, rods, etc.

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Round, oval, square, rectangular and special shaped washers or pieces for insulating arc lamps, grid rheostats and similar apparatus.

There is no shortage of these built-up mica products!

DIRECTING electrical traffic, guiding current along its predetermined path, keeping electrical equipment on the job to turn out more of the nation's war goods . . . that's the way these *Micanite Products* can help you.

Always the pioneer in developing tougher, more serviceable mica products, we have ample raw materials and production facilities today to keep an adequate supply of the best quality built-up mica insulation available for the increased requirements of all branches of the electrical industry.

Let us know your requirements. Send specifications or blueprints for prompt action on any or all of the products listed.

MICA INSULATOR COMPANY
200 Varick St., NEW YORK
600 Van Buren St., CHICAGO
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501 Marion Bldg., CLEVELAND

MICA INSULATOR CO., Dept. 31, 200 Varick St., New York, N. Y.

We are sending specifications, blueprints or samples of_____

insulation required for_____

Quote prices and delivery. This is NOT an order.

*Name*_____ *Title*_____

*Company*_____

*Address*_____

Corp. These machines have revealed that supposedly congested highways are crowded only at a certain period of the day or only on certain days of the week. In some cases congestion has been relieved by shunting part of the traffic over other routes during the high-traffic periods.

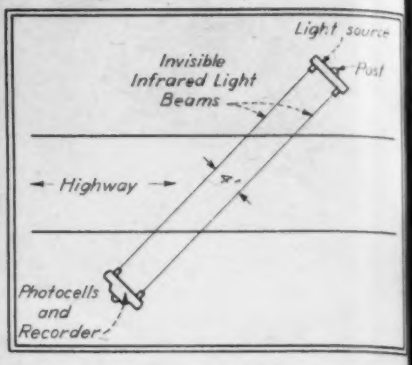


Fig. 1—Arrangement of twin light beams across highway. These units are made portable so that they can be moved to another location as soon as traffic conditions in one location have been determined

The arrangement consists of two infrared light sources mounted on a post on one side of the road, directing two beams of invisible light diagonally across the road to two photocells in the recorder unit similarly mounted, as shown in Fig. 1. The beams are about 3 feet above the highway and 4 feet apart, and the photoelectric system is designed so that both beams must be interrupted simultaneously to operate the recorder. This prevents a pedestrian from actuating the recorder.

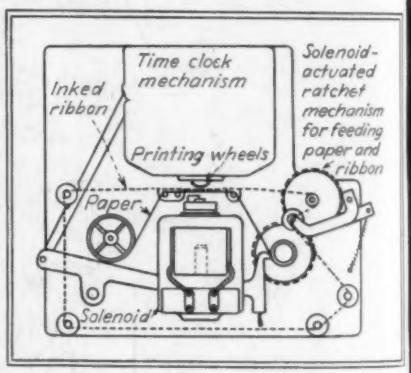
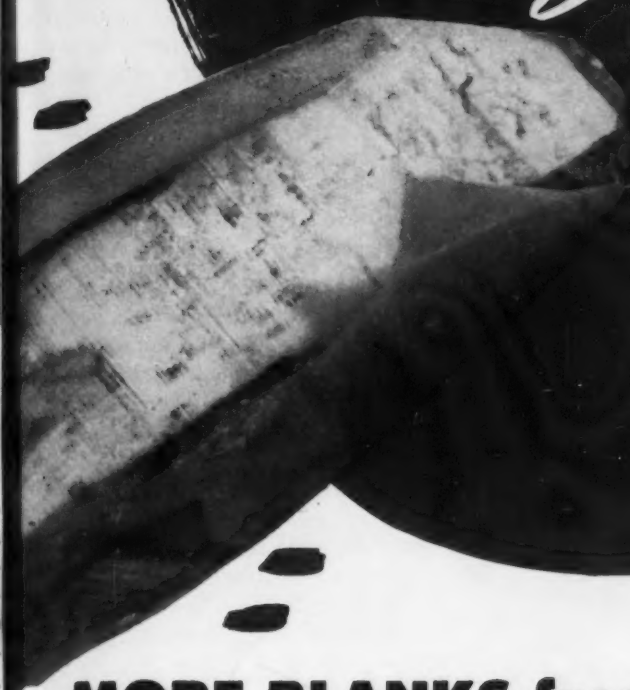


Fig. 2—Simplified sketch showing essential parts of the recording mechanism

A synchronous motor timing device in the recorder is arranged to print the date, time and accumulated total of traffic once every hour. Printing is accomplished by a solenoid which forces a paper ribbon against an inked ribbon backed by the printing wheel, as in Fig. 2.

Quartz shortage



REQUIRES GREATER CUTTING ACCURACY . . . LESS WASTAGE . . . FEWER DUDS

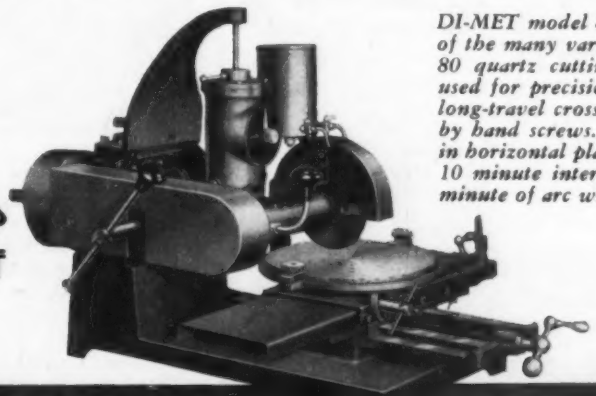
Limited quartz supplies demand more accurate cutting to obtain the greatest number of acceptable blanks per block. Because of design and features engineered especially for cutting quartz, Felker DI-MET machines not only cut to exceptionally close tolerances, assuring a maximum quantity of accurate blanks per pound, but keep production at peak with minimum breakage and with excellent surface finish!

MORE BLANKS from the same quartz

For highly consistent and accurate results DI-MET models 80 and 120 quartz cutting machines are equipped with the Felker Hydraulic Retardant. This Retardant controls down-feed to a definite speed, which can be adjusted from a fraction of a foot to 10 feet per minute.

Cutting speed of the DI-MET Rimlock or DI-MET Resinoid blade is always well in advance of the feed rate, and the movable arbor is so balanced as to permit utilizing the most efficient blade pressure upon the quartz without forcing. Blades will not bind or buckle because excessive and variable pressures are impossible, thus eliminating runouts and breakage of crystals. Feeds remain constant regardless of surface area being cut. Wafers and blanks are sliced truer and sides are kept parallel because cutting action is uniform from start to finish. Instant acting controls permit rapid employment or disengagement of Hydraulic Retardant for raising or lowering the arbor. These and many other desirable DI-MET features with specifications on all DI-MET quartz cutting machines are fully described and beautifully illustrated in our new catalog. If you cut quartz, write for your copy today!

FELKER MANUFACTURING CO., 1116 BORDER AVE., TORRANCE, CALIF.



DI-MET model 80 with HVCT-12 Rotary Table — One of the many variations of the versatile DI-MET model 80 quartz cutting machine. HVCT-12 Rotary Table, used for precision orientation of the quartz piece, has long-travel cross and through-feeds manually operated by hand screws. Table tilts to ± 10° and rotates 360° in horizontal plane. Vertical adjustment is graduated in 10 minute intervals, horizontal adjustment reads to 1 minute of arc with vernier.

FELKER DI-MET

MANUFACTURERS OF DIAMOND ABRASIVE WHEELS

★ Those green-colored (for identification) power resistors found more and more in severe-service electronic, radio and electrical assemblies these days are **Greenohms.**

They are **extra-rugged,** as proven by impartial tests and the service records out in the field. The extra safety factor is due to the exclusive inorganic cement coating in which the resistance winding is imbedded and protected. This coating provides improved radiation of heat for cooler operation. Also, this coating will not crack, flake or peel despite severe overloads and heat shock.

Standard types in 5 to 200 watt sizes as fixed resistors, and 10 to 200 watt sizes as adjustable resistors. Special types in widest range of terminals, mountings, taps, sliders, etc.

★ **For that assembly in which you seek extra safety factor, consider GREENOHMS. They cost no more. Remember, only Clarostat makes GREENOHMS. Let us quote on your high-priority requirements. Literature on request.**

CLAROSTAT *Controls and Resistors*

CLAROSTAT MFG. CO., Inc. · 285-7 N. 6th St., Brooklyn, N. Y.

Bounceless Relay Contacts

THE FACT THAT A STEEL ball par filled with metallic powder will bounce has been utilized by We inghouse engineers to elimina bouncing and chattering in the c tacts of fast-acting relays. The re contacts themselves are made holl and are partly filled with metal powder, or special hollow pow containers are attached to the m ing contacts or to an extension of t contact arms.

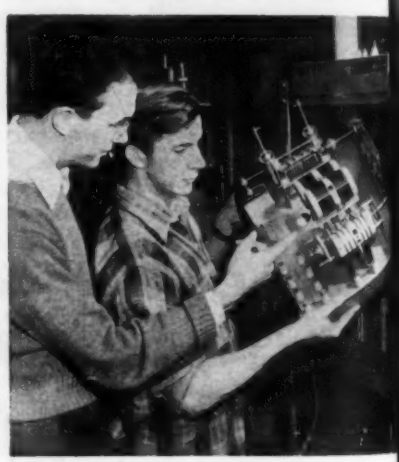
• • •

Recording Sunlight Intensity

CONTINUOUS RECORDS of variatio in sunlight intensity throughout t day are being obtained at the gree houses of Ohio State University b a photo-electric cell mounted abo the peak of the greenhouse roof a connected directly to a Leeds Northrup Micromax recorder. T resulting sunlight data is being us in connection with the study of so less horticulture. An Eppley py heliometer may be used in place the photocell if desired.

• • •

N.Y.A. TRAINS WAR WORKERS



A pre-employment program of work experience in organized shop training for young people between the ages of 16 and 24 is being offered by the National Youth Administration to those interested in entering war industries. Hundreds of skilled workers are going from the school, at NYA's Quoddy Village School, Eastport, Maine, each month direct to war factories. William Greenwood, student, is working on a 250-watt transmitter under the supervision of Robert Blaney, instructor

COMMANDOS of the Assembly Line...

Speed Nuts they're tough!

SPEED NUTS are truly the commandos of the assembly lines. They are tough — and fast in action.They are now being rushed into aircraft factories where they are vitally needed on the assembly lines.

Spring Steel SPEED NUTS are approved by the U. S. Army Air Forces and the Bureau of Aeronautics for most all non-structural attachments. Conversion to the use of Speed Nuts on all approved applications releases critical bar stock steel for other important uses.

Our Engineering Dept. will be glad to assist you in determining the proper approved locations where SPEED NUTS may be used. Request for information or assistance will receive immediate attention.

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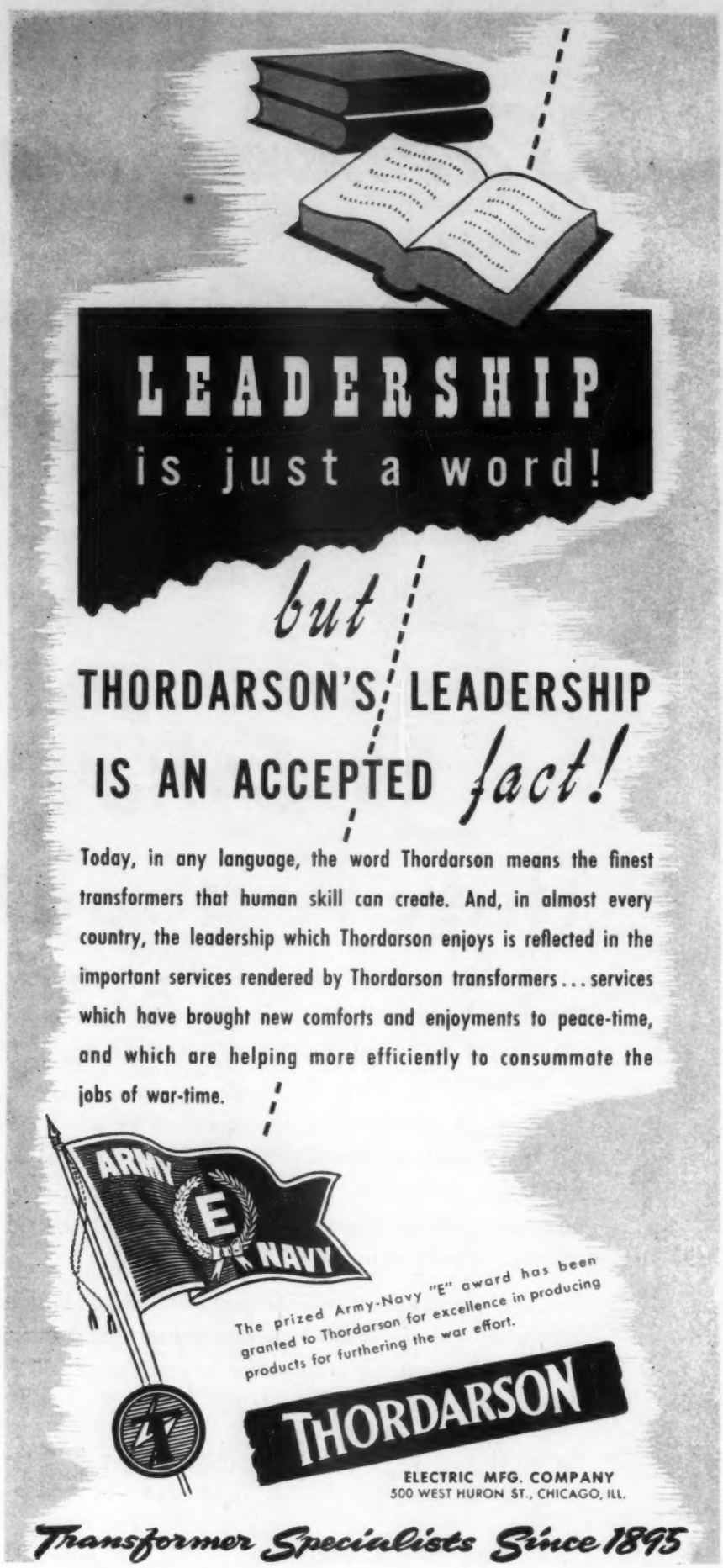
Speed Nuts THE FASTEST THING IN FASTENINGS! Speed-Clips


LEADERSHIP
is just a word!
but
THORDARSON'S LEADERSHIP
IS AN ACCEPTED fact!
Today, in any language, the word Thordarson means the finest transformers that human skill can create. And, in almost every country, the leadership which Thordarson enjoys is reflected in the important services rendered by Thordarson transformers... services which have brought new comforts and enjoyments to peace-time, and which are helping more efficiently to consummate the jobs of war-time.
ARMY E NAVY
The prized Army-Navy "E" award has been granted to Thordarson for excellence in producing products for furthering the war effort.
THORDARSON
ELECTRIC MFG. COMPANY
500 WEST HURON ST., CHICAGO, ILL.
Transformer Specialists Since 1895

Post-War Planning

(*Continued from page 73*)

competition. Such competition appears certain in view of the fact that until quite recently the government found it desirable to induce factories never before in the field to enter it. Where especially critical bottlenecks occurred, old established plants frequently helped to set up their own future competition, supplying advice and at times engineering personnel and even machinery.

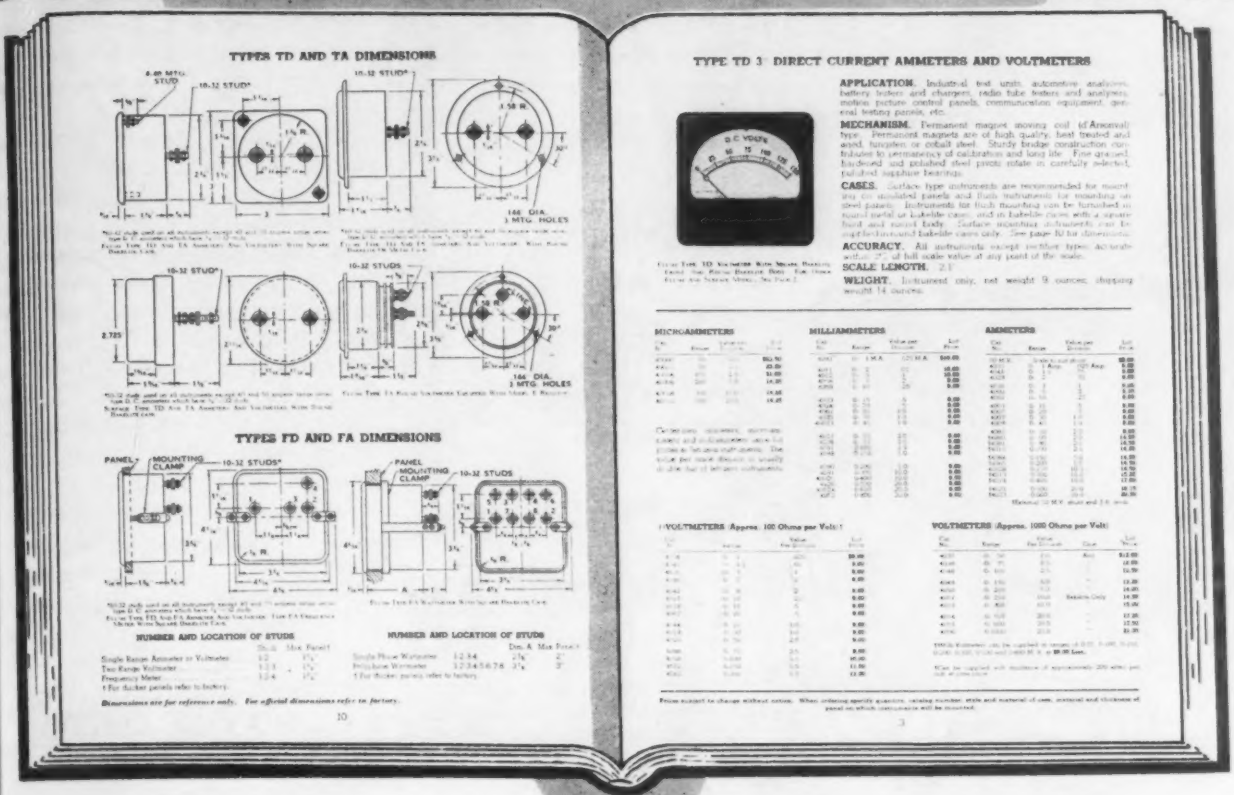
Some of the newcomers may automatically drop out of the picture when Washington orders dwindle but a considerable number will naturally carry on and make at least a temporary dent in the commercial market. A few will undoubtedly become important factors. To offset this competition, manufacturers with brand-names well entrenched before the war and since kept alive will have vastly increased production facilities and the attractive prices which volume purchasing power permits. Size is not an unmixed blessing, however, as the old-time manufacturers are likely to be simultaneously engaged in something of a struggle among themselves because of this selfsame expansion in production facilities.

Contrary to popular opinion, it appears from discussions with men in many branches of the business that while radically new products will receive their share of attention, these are for the most part thought of as future sidelines, to be developed gradually rather than overnight. Varying in importance, they will probably play second fiddle, at least in the immediate post-war period, to products for which their manufacturers were best known before December 7, 1941. There may be some shifting of product emphasis but complete change of direction on the part of established firms will be the exception rather than the rule.

Time Element

The problems detailed above and their subdivisions are those at present most frequently discussed among manufacturers. Accompanying interpretations contain, of course, some of the thinking of the reporter and are subject to the usual human

Dimensions AND Facts



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ELECTRICAL INSTRUMENTS

PANEL INSTRUMENTS
A.C. and D.C. Ammeters, Milliammeters, Voltmeters, Millivoltmeters, Wattmeters, Galvanometers and Pyrometers.

PORTABLE INSTRUMENTS
Small, Medium and Large
For same measurements as panel instruments in addition to Frequency Meters and Power Factor Meters.

POCKET SIZE INSTRUMENTS
for any required measurements

CIRCUIT TESTERS
for reading resistance of circuits under test

SWITCHBOARD INSTRUMENTS
including Power Factor Meters and Syncroscopes

PRECISION BALANCES
for accurate, rapid weighings of .002 mg to 50 grams

For Designers and Operating Men

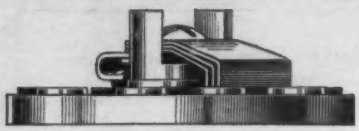
The extensive line of Roller-Smith instruments contains just the one you need . . . in the size and accuracy you need it—whether it be ammeters, milliammeters, or voltmeters. And these Roller-Smith catalogs prepared by engineers give Electronic Engineers and operating men the information on Metering and Control instruments required for their work in Communications, Industry or the Laboratory.

Accordingly, ranges . . . scale divisions, volt-ampere burdens, as well as extensive sketches showing necessary dimensions and mounting details are given in full.

The construction, operating principles and accuracy of Roller-Smith Panel Instruments merit your close scrutiny. So we suggest that you write us on your Company letterhead, listing those instruments or equipment in which you are interest — either now or for post-war work. We will combine the requested data in a loose-leaf book especially compiled for you.

ROLLER SMITH **ROLLER-SMITH COMPANY** BETHLEHEM, PENNA.

"SHORTING" Switches

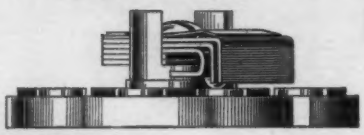


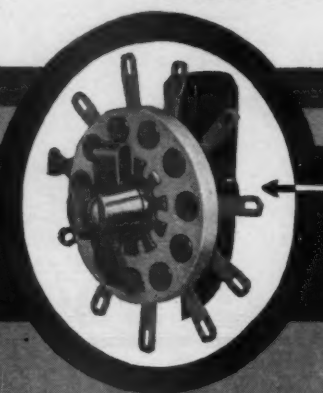
This is the shorting type. As the arm is rotated from one position to another the adjacent contact points are "shorted" (bridged).

or

"NON-SHORTING" Switches

This is the non-shorting type. As the arm is rotated from one position to another, the arm lifts up, and only one contact is touched at a time.





OTHER SHALLCROSS Switches are designed for use in your particular field.

Let Shallcross answer your problems.

Address Dept. C-3

THE No. 4605 is one of many Shallcross Switches extensively used in instruments and in many other applications.

SHALLCROSS ROTARY SELECTOR SWITCHES USE SOLID SILVER CONTACTS, BECAUSE SOLID SILVER . . .

1. Has the highest conductivity of materials available.
2. Is superior to silver-plating which wears off, resulting in high resistance contacts.
3. Should it corrode the sulphide formed does not appreciably increase the contact resistance.

Creators and Makers of

Accurate Resistors—Switches—Special Equipment and Special Measuring Apparatus for Production and Routine Testing of Electrical Equipment on Military Aircraft . . . Ships . . . Vehicles . . . Armament . . . and Weapons

SAMA

SHALLCROSS MFG. CO.

COLLINGDALE, PENNA.

error. Comment, for this reason, is particularly invited. The important objective at the moment, second only to prosecution of the war, is stimulation and coordination of whatever post-war planning effort the pressing production problems of today leave time for.

The need for heavy duty electronic power equipment used by certain raw material processing industries is already tapering off as giant plants near their maximum practical productive capacity. While no such decline in demand is noted in connection with "expendable" gear used on the battle fronts and manufacturers still appear to be feeding this gear into a vacuum, it is a fact that firm orders on the industry's books rarely date beyond the fall. No one knows precisely what the requirements will be next year. This uncertainty alone suggests that it is not too early to do a little quiet thinking about the future.—W. MACD.

• • •

Tubes for Ultraviolet Radiation

(*Continued from page* 85)

the current is first carried by the starting gas only. It should be noted, therefore, that during each starting cycle the tube first operates as a low-pressure discharge between electrodes that are "cold" at the beginning. As a relatively high starting current is demanded from the electrodes a considerable strain is put on them during each starting cycle, thus noticeably affecting the life of the tube. The electrodes warm up rapidly to incandescence under the ionic bombardment, but it takes several minutes for enough mercury to evaporate and to produce a pressure sufficiently high to protect the electrodes from rapid disintegration. These starting conditions, therefore, have to be carefully considered in the design of high-pressure tubes.

As the tube warms up and the pressure increases, the mercury vapor takes over more and more of the discharge. Finally, after all the mercury has been evaporated, equilibrium is reached between the input of energy and the dissipation of heat. The tube has then attained maximum intensity. The arc is confined to a brilliant narrow cord in the axis of the tube, this being char-

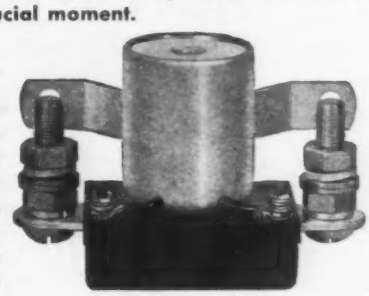
Relays by Guardian

COVER A WIDE RANGE OF CONTROL APPLICATIONS FOR WAR PRODUCTION...FOR POST-WAR PLANNING

To guard your home against theft . . . to guard your property against fire . . . to guard against accidents in your plant . . . to guard your city and country against wartime destruction. In such alarm and safety systems, "Relays by Guardian" are almost a necessity because not all relays can withstand the inroads of weather and time and yet respond dependably at the crucial moment.

LIGHTWEIGHT AIRCRAFT CONTACTORS...

The SC-25 and SC-45 lightweight contactors have double wound coils drawing 2 amperes to close the contacts vigorously. The current is then reduced to .180 amperes which is sufficient to keep the contacts firmly closed. These new contactors are interchangeable with earlier types B-4, B-6A and B-7A. Another new contactor is the B-8 which is interchangeable with the B-4 on intermittent duty applications. The B-8 handles inrush currents up to 1500 amperes. Contacts close firmly at 6 volts. All of these units are built to U.S. Army Air Force specifications. Write on your business letterhead for these bulletins:



B-8 Solenoid Contactor

"B-8", six pages of Aircraft Contactors—"No. 195", on Midget and Signal Corps Relays

GUARDIAN ELECTRIC

1625-F WEST WALNUT STREET — CHICAGO, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

Industrial's high standard of quality parallels that of the famous Hallicrafters HT-4B transmitter in the field of communications.

INDUSTRIAL CONDENSERS ARE ON EVERY BATTLEFRONT WITH THE WORLD-FAMOUS hallicrafters COMMUNICATIONS EQUIPMENT

PAPER, OIL AND ELECTROLYTIC CAPACITORS

INDUSTRIAL CONDENSER CORPORATION

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DISTRICT OFFICES IN PRINCIPAL CITIES
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acteristic of the high-pressure arc after it has reached the steady state condition.

The quartz tube of Fig. 7 may be enclosed in a second glass tube having certain filter characteristics. For instance, Corex D glass may be used if it is desirable to exclude the short-wave ultraviolet which produces ozone and if a high output in the medium and long ultraviolet is wanted.

High-pressure quartz mercury arc tubes are used extensively as generators of therapeutic and prophylatic ultraviolet. Their high output in the medium and short-wave range of the spectrum makes them the most efficient and most versatile source of therapeutic ultraviolet radiations. Of equal importance is their application to photo-chemical processes of many kinds in the industries. A few examples must suffice here to show their many commercial applications.

Tubes with a radiant length of four or five feet and of an input of several kw are used in thousands of photo-printing and blue-printing machines and in similar reproduction apparatus. Photo-sensitive coatings of the Diazo or ferro-salt type applied on papers for reproduction from transparent originals are particularly sensitive to the long ultraviolet, as indicated by the solid-line curve in Fig. 1.

Has Many Advantages

A powerful linear source of ultraviolet rays with uniform output over the entire width of the paper has many advantages over "point sources". Carbon arcs, for instance, require special reflectors to attain uniform intensity on the printing surface, and have to be carefully controlled to avoid flickering with resulting shadows on the prints. Carbon arcs also have to be trimmed regularly, whereas high-pressure mercury vapor tubes ordinarily do not require any service after they are once installed.

The high efficiency in the spectral range of radiations which activate Vitamin D in sterols (about 2400-3000 Angstrom units) makes the high-pressure mercury arc in quartz the preferred source in apparatus for the irradiation of milk and other foodstuffs and Pro-Vitamins for pharmaceutical use. Of the many additional industrial applications of high-pressure tubes, only their use

WELDRAWN is Superior's Answer to Industry's Need for Welded Stainless Tubing

(MAXIMUM O. D. 5/8")

SUPERIOR

The big name in SMALL TUBING *for Uncle Sam!*

SUPERIOR TUBE COMPANY, NORRISTOWN, PENNSYLVANIA

FOR EVERY SMALL TUBING APPLICATION

Tubing from 5/8" OD down...SUPERIOR Seamless in various analyses. WELDRAWN Welded and drawn Stainless.

BRAWN Welded and drawn "Monel" and "Inconel". SEAMLESS and Patented LOCKSEAM Cathode Sleeves.

GOULD-MOODY "BLACK SEAL" GLASS BASE INSTANTANEOUS RECORDING BLANKS

—acclaimed as the finest, yet they cost no more than ordinary blanks!

Can you really afford not to give them a hearing under your most exacting conditions?

"The frequency response obtainable is superior to any we have yet used."

"We stood in wonderment at the complete lack of surface noise."

"Have played our first recording back more than 90 times without appreciable loss of fidelity"

"Your aluminum recoats have the greatest uniformity on both sides of any we have used."

"We are particularly pleased with a disc that has holes precision machined directly in the glass. Other makes we have used have inserts that warp."

"The most amazing thing is the thread action." "Your package gives us a clean, unmarred disc 25 times out of 25."

(Excerpts from letters from Major Broadcast Engineers from coast-to-coast. Names on request.)

Here's Our Guarantee!

If, after trying "Black Seal" Blanks *you are not convinced that they're better than any you've ever used, we'll stand all expenses. You'll pay nothing!*

Old Aluminum Blanks Recoated with the famous "Black Seal" Formula in 24 Fast Hours!

Write for details of the brand new Pac-KARTON* Shipping Container. Lightweight, corrugated boxes that save time, save records, reduce your shipping costs.

*Reg. U. S. Pat. Off.

LET'S ALL TOP THAT 10% WAR BOND PURCHASE PLAN

the GOULD-MOODY company
Recording Blank Division, 395 Broadway, N. Y. C.

for catalytic reactions in the synthesis of rubber and the manufacture of organic halogenation products may be mentioned here.

A series of high pressure tubes with wattage imputs ranging from 85 to 400 watts is commercially available. The arc in these tubes ranges in length from ¾ inch to 6¼ inch and is enclosed either in a tube of fused quartz or hard glass. The outer envelope can be made of a glass with a variety of filter characteristics, such as Pyrex, Corex or a red-purple glass which transmits long ultraviolet with hardly any visible radiation. The latter filter is very useful for fluorescent applications. High-pressure tubes with outer bulbs of clear glass are widely in use in the film processing plants of the motion picture industry for the printing of release and daily films on automatic printers. Their spectral characteristics are especially advantageous for the processing of fine grain film and for sound track recording.[5]

Electrical Control Circuits

High-pressure tubes are operated from special electrical control units designed to furnish an open-circuit voltage sufficiently high to insure safe starting and to prevent the arc from going out when the supply voltage drops. The higher the ratio of open-circuit to arc voltage is made, the smaller will be the variations in wattage input to the tube if the supply voltage fluctuates.

Careful consideration also has to be given to the ratio of starting current to operating current, as it affects the warming-up time of the tube. Usually the control units are designed as reactive-type transformers, with power factor correction by means of capacitors.

A number of interesting circuits have been developed for controlling the radiation output of the ultraviolet tubes automatically.

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(2) Overholt, Richard H., and Betts, Reeve H., A Comparative Report on Infection of Thoracoplasty Wounds, *Journal of Thoracic Surgery*, **9**, p. 520, June 1940.

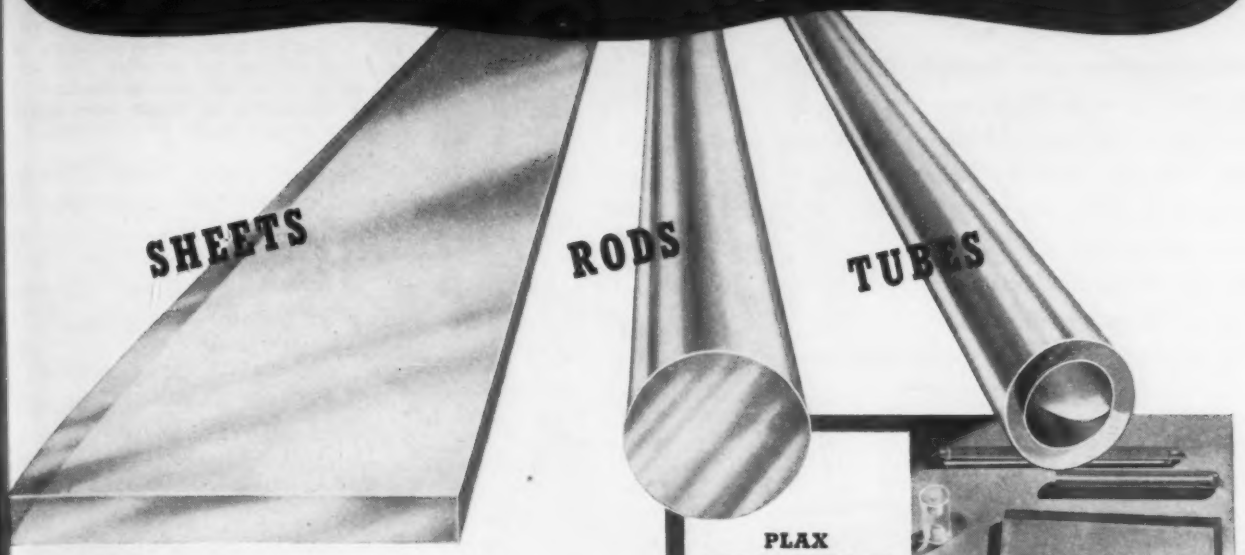
(3) Laub, J. H., Powerful Ultraviolet Light Sources, *Electrical Engineering*, August, 1941.

(4) Anderson, Jr., Wm. T., Mercury Arc Lamps: Effect of Electrode on Energy Distribution, *Journal of the Optical Society of America*.

(5) Wilkinson, James R. and Eich, Ferdinand L., Laboratory Modification and Procedure in Connection with Fine Grain Release Printing, *Journal of the Society of Motion Picture Engineers*, **38**, p. 56, 1942.

PLAX POLYSTYRENE

IN SEVERAL OF ITS FORMS AND USES . . .



High-frequency circuits insulated with Plax Polystyrene have the highest efficiency. This has been proved in the field.

Zero water absorption . . . complete freedom from adverse effects by acids, alkalis, alcohol, stack gases, weather, etc. . . . the dielectric strength of high-grade mica . . . the low dielectric loss of fused quartz . . . all combine to make Plax Polystyrene in any of its various forms the best high-frequency insulation ever made.

Many companies buy Plax Polystyrene sheets, rods, and tubes to machine into antenna components, stand-off insulators, buss bars, windows, etc. Details regarding your own possible applications, and a bulletin on machining, are immediately available.

PLAX POLYSTYRENE SHEET, ROD, TUBE

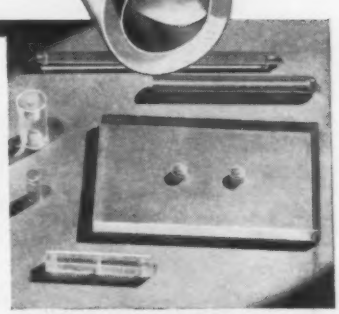
Sheets range in thickness from .010" to 1½", and in widths and lengths to order ranging from 4" x 48" to 12" x 16". Rods come in diameters from 3/32" to 4½". Tube inside diameters range from ⅛" to 2". Lengths as required. 4' lengths in stock.

PLAX POLYSTYRENE Electrical Properties

Arc resistance (ASTMD-495-38T) sec 240-250. Dielectric strength, volts/mil:

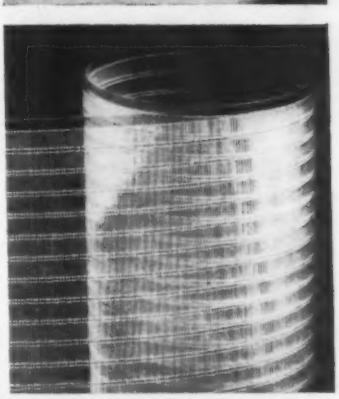
.005" thick = 3500
.010" thick = 2500
.015" thick = 2200
.125" thick = 500-700

Frequency Cycles	Dielectric Constant	Power Factor
60	2.5-2.6	.0001-.0002
1,000	2.5-2.6	.0001-.0002
1,000,000	2.5-2.7	0001-.0004



PLAX POLYSTYRENE Machined Parts

Here are a few of the multitude of standard and special parts which Plax machines to order. Sizes are large to tiny. Production is rapid and accurate.



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THE ELECTRON ART

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Encephalophone Converts Brain Potentials into Sounds

AN ELECTRONIC INSTRUMENT which converts brain potentials of the order of 10 microvolts to audio tones is described by C. A. Beevers and Dr. F. Futh in the March 1943 issue of *Electronic Engineering*, a British publication. It is intended for practical clinic use in making surveys of large numbers of cases. From these aural indications, appropriate cases can be selected for further examination with conventional electromagnetic or cathode-ray oscillographs providing permanent records.

Conventional electronic methods of measuring brain potentials were described by Walter E. Rahm, Jr., in the article "A New Bio-Electronic Application — Electroencephalography" in the October 1939 issue of ELECTRONICS. Push-pull a-f amplifier stages having a flat frequency response over the range from 1 to 45 cycles were used here to amplify brain potentials sufficiently to drive an improvised ink recorder. Examples of the resulting records are shown in Fig. 1. No brain waves of higher frequency had been reliably reported up to that time.

The person from whom a record is being taken is placed in a completely shielded room to minimize 60-cycle pickup. The electrodes used

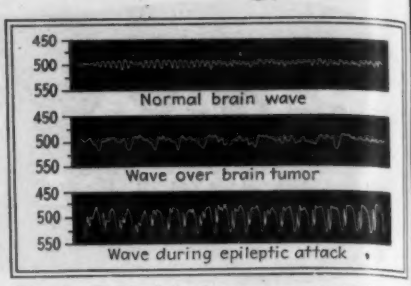


Fig. 1—Typical brain wave potentials as obtained with an ink recorder. The vertical scales at the left indicate the range of audio frequencies to which these waves are converted by the encephalophone

are discs of solder about ¼-inch in diameter and ⅛-inch thick, recessed on one side to retain a small amount of conductive electrode jelly. The electrodes are held on the scalp with collodion, and it is not necessary to remove hair to secure a good contact. Any desired number of electrodes can be installed initially and connected to a rotary selector switch, to permit quick changeover to different parts of the scalp during observation.

The audio method to which the authors have assigned the name "encephalophone" makes it possible to watch a non-cooperative patient and thus identify extraneous potentials arising from friction, body movements, muscle activity or eyelid movements. In visual methods it is not always easy to do this and at the same time watch the voltage pattern on the screen or paper. The frequency of the audio tone varies in accordance with brain potential changes, and the resulting slow changes in musical pitch are easily

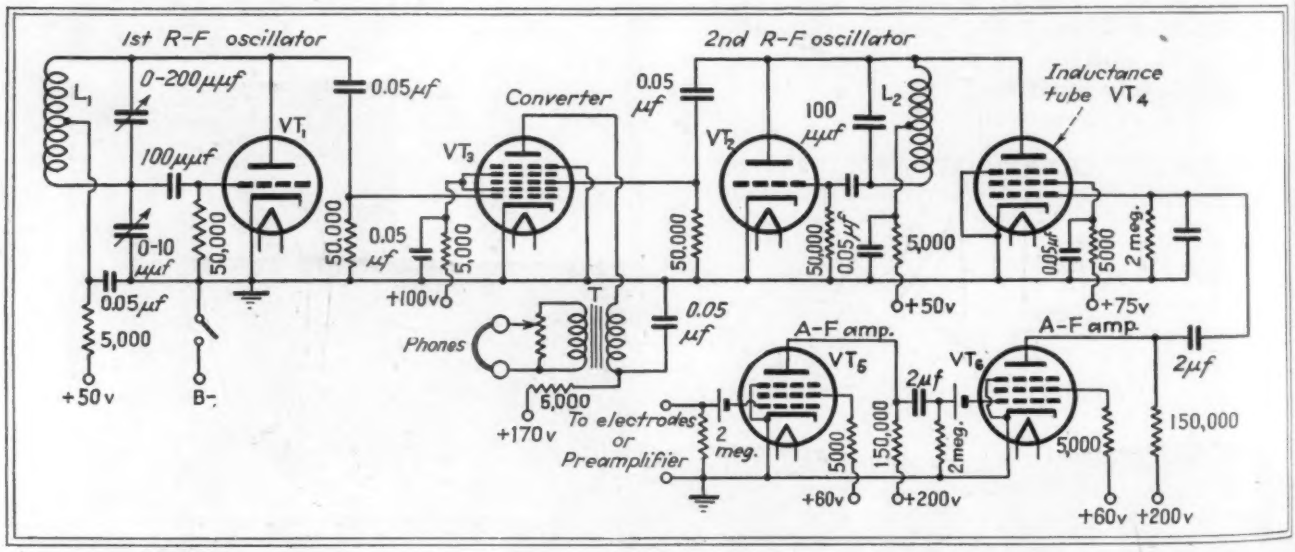
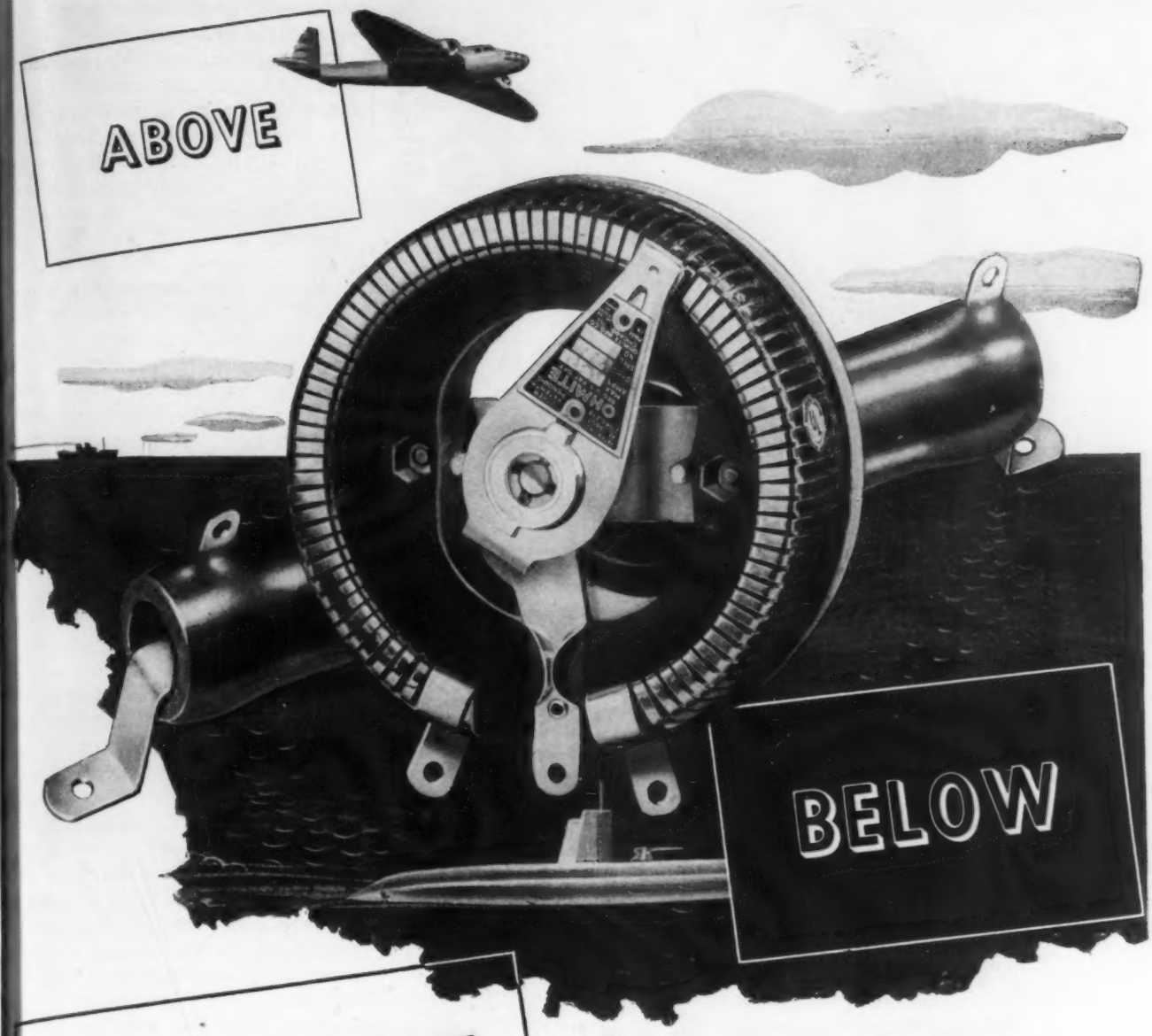


Fig. 2—Circuit diagram of encephalophone developed for electrobiological research, utilizing frequency modulation principle to convert slowly changing brain potentials into an audio tone changing correspondingly in frequency



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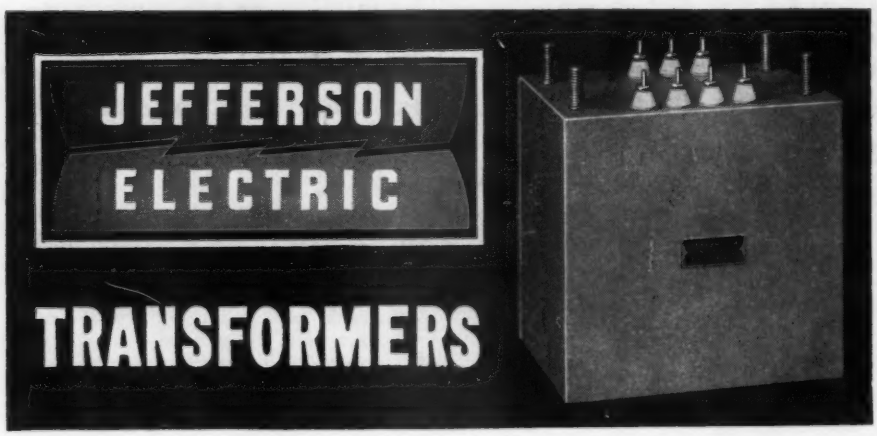

interpreted by the observer in terms of potential changes.

Brain potentials vary so slowly that the frequencies involved are far below the range of audibility and can be amplified directly only with special a-f circuits. For this reason a frequency modulation method was used. Two r-f oscillators, operating at about 5,000,000 and 5,000,500 cycles respectively, normally produce a 500-cycle beat frequency in a converter stage. If, for example, the brain potential is made to vary the frequency of one oscillator by 50 cycles, the beat note will also change 50 cycles, and the resulting change in audio tone will be easily recognized.

The circuit diagram of the instrument is shown in Fig. 2. The r-f signals are produced by triodes VT_1 and VT_2, each in a Hartley oscillator circuit. The outputs of these oscillators, of the order of 5 Mc, are electronically mixed in converter tube VT_3, and the difference frequency in the plate circuit is transferred to the headphones through audio transformer T.

Frequency modulation is achieved in a conventional manner with variable-mu pentode VT_4, which is in effect connected in parallel with the second r-f oscillator circuit. A change in the control grid voltage of this tube varies the plate impedance of the tube, thereby varying the frequency of the oscillator circuit across which it is connected.

It was found that a voltage of 0.1 volt applied to the grid of VT_4 produced a change in tone easily recognized by anyone. Brain potentials being of the order of only 10 microvolts, considerable amplification was necessary. In the experimental apparatus a separate two-stage preamplifier unit was used to feed the two resistance-capacity coupled amplifier stages using tetrodes VT_5 and VT_6 respectively.

Because of the high value of the time constant of the amplifier, it takes about one minute for normal conditions to be re-established after the instrument is switched on or after the electrodes are handled. During this period the pitch of the tone changes, finally becoming steady. A charged insulator such as a fountain pen, waved in the air two feet away from the ungrounded electrode, transforms the steady tone to a trill.

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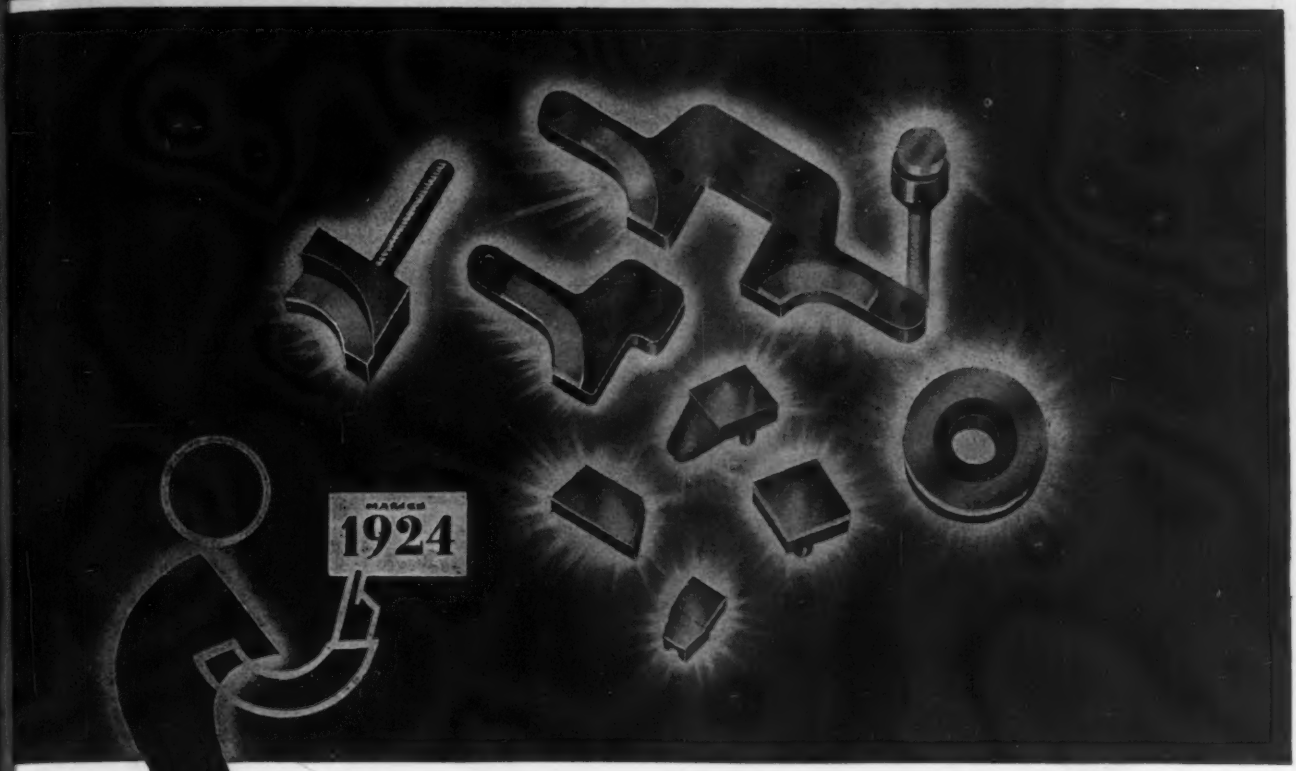

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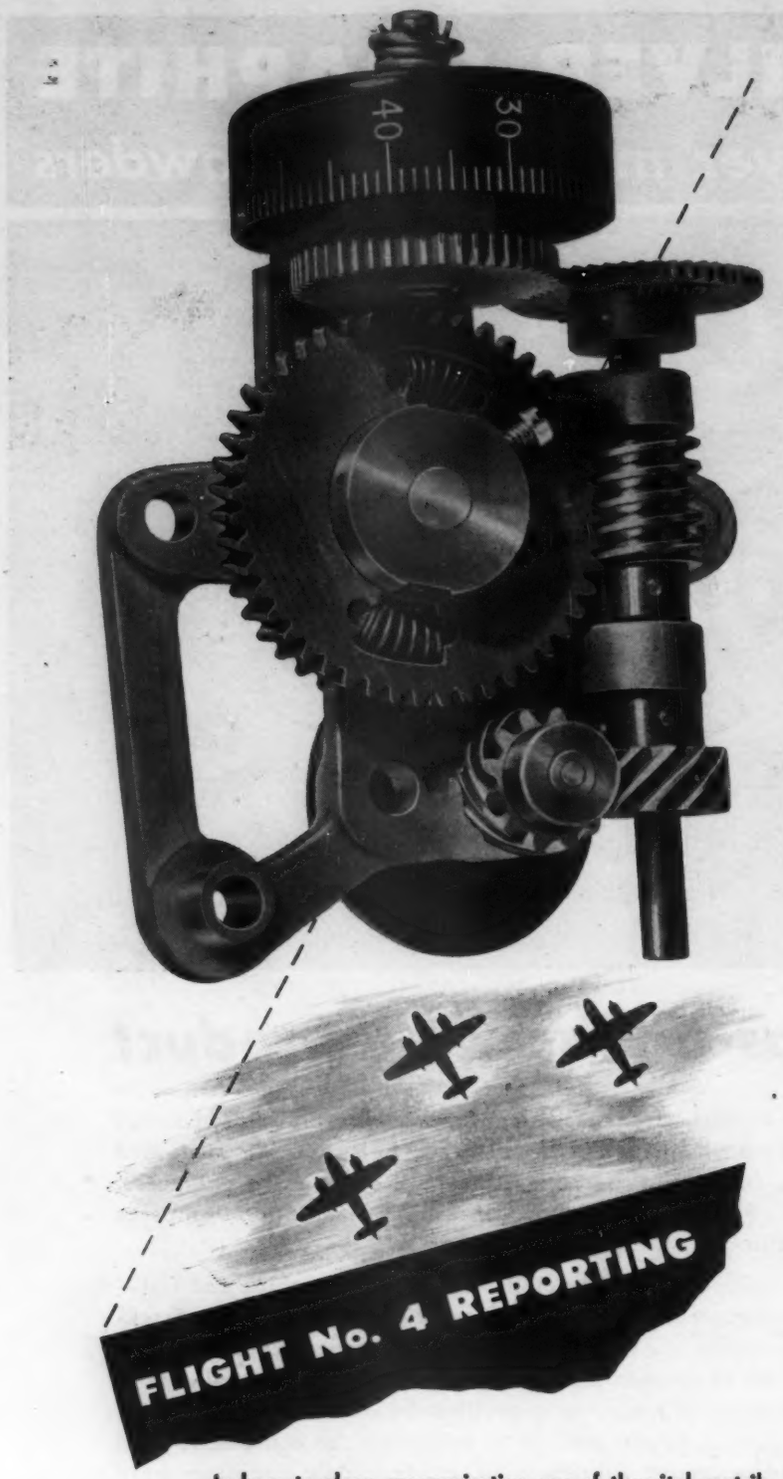

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If a more accurate indication o the magnitude of a brain potentia is desired, an artificial source of ver small potential changes can be in-corporated in the instrument an made to produce the same changes i pitch as are observed. The voltage involved can then be read directl on a calibrated potentiometer.

• • •

New Frequency Meter

A NEW METHOD of frequency measurement, capable of measuring power line frequencies to within 0.00 cycle without estimating fraction of a scale division, is described b H. L. Clark and J. E. Hancock in the Feb. 1943 issue of *Instruments*. A tuning fork is driven by the system frequency instead of being allowed to vibrate freely, and the phase angle between the motion of the fork and the applied line frequency is measured electronically to obtain an accurate indication of the line frequency.

When a tuning fork is so mounted as to be free to vibrate, and a sinusoidal driving force is applied, the resulting motion can be predicted mathematically. When the disturbing force is much lower in frequency than the resonant frequency of the fork, the motion will be *in phase with* and proportional to the disturbing force. When the disturbing force is much higher than the resonant frequency of the fork, the motion will be *180 deg. out of phase* with the applied force and very small. When applied and fork frequencies are the same, the resulting motion will be limited only by the damping in the system and will be *90 deg. out of phase* with the disturbing force. In the narrow frequency band surrounding the resonant peak, the phase angle changes rapidly and is proportional to the deviation of the applied frequency from the resonant frequency of the fork.

The accompanying diagram gives the basic circuit of the new frequency meter. Only a single connection is required to the 120-volt, 60-

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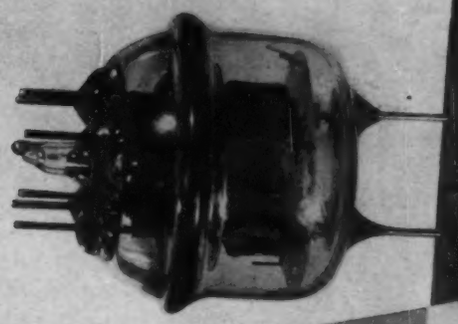

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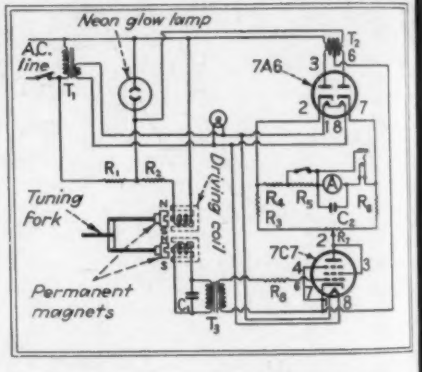
cycle line whose frequency is to be measured. The total operating power is only about 5 watts, used chiefly for cathode heating.

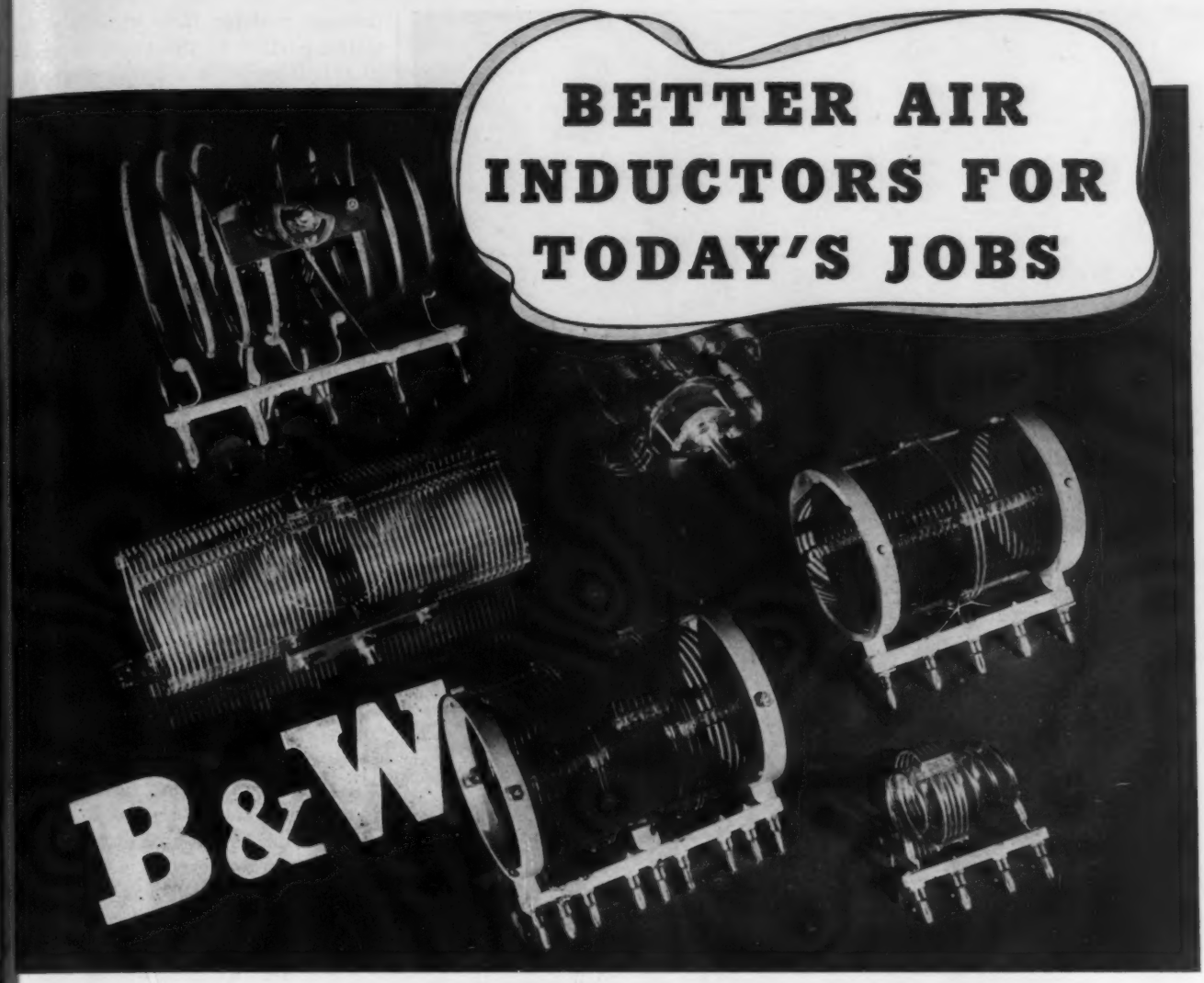
The voltage across the neon lamp is used in the actual measurement. It has a square-wave shape because of R_1 in series with the neon lamp, and this minimizes the effects of line voltage variations and harmonics in the line voltage. This voltage is applied to the driving coil of the tuning fork through resistor R_2, causing the fork to vibrate at the power line frequency because of the alternating force acting on the magnet at the end of the fork arm. The same voltage is also applied through transformer T_2 to the type 7A6 full-wave rectifier tube.

On the other arm of the fork is another magnet, which vibrates with the fork and generates in its own coil a voltage corresponding to the motion of the fork. This voltage, roughly tuned by C_1 and the primary of a-f transformer T_3, is applied to the type 7C7 tube. The voltage is sufficiently high to make the tube alternatingly conductive and nonconductive. Since the 7C7 is in effect connected in series with the cathode return circuit of the 7A6 rectifier, the lower arm of the fork in the diagram effectively controls the rectifying action of the 7A6.



Circuit of new supersensitive frequency meter for power line frequencies

When the power line frequency is exactly 60.000 cycles (the resonant frequency of the fork), the phase shift is exactly 90 deg. and hence the 7C7 tube is turned on in the exact center of each positive half-cycle, and turned off in the center of each negative half-cycle of the current flowing through the 7A6 tube. Now the portion of the rectified positive half-cycle flowing



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through resistor R_3 is exactly equal to the portion of the rectified negative half-cycle flowing through R_4, no current flows through indicating instrument A, and hence the pointer stands at the mid-scale point marked 60 cycles.

When the line frequency goes above or below 60 cycles, the phase angle of the generated voltage changes corespondingly, disturbing the balance between the rectified quarter-cycles of current flowing through R_3 and R_4. The resulting difference in current flows through the indicating meter, which is calibrated to read directly in cycles. Resistors R_4 and R_5 control the sensitivity of the circuit, hence shorting of R_5 increases the sensitivity and narrows the indicating range. In a commercial model of the instrument as made by General Electric Co., the normal range is 59.75 to 60.25 cycles, and the high-sensitivity range (with the shorting switch closed) is 59.875 to 60.125 cycles.

Rheostat R_7 permits calibration of the instrument and compensation for any small frequency deviation in the tuning fork or phase angle deviation in the transformers.

The tuning fork is made from Maginvar, an Invar-like material developed by the General Electric Research Laboratory especially for the purpose and having well-balanced and very low temperature coefficients of expansion and elasticity. The stability of the tuning fork and the circuit are such that the over-all precision is limited only by the precision of reading the scale of the instrument. Tests indicate that a scale range of plus or minus 0.01 cycle is entirely possible if the instrument is mounted in a temperature-controlled compartment.

This supersensitive frequency meter was originally developed to provide a frequency record as a measure of the speed of a steam turbine while checking the operation of the governor. The recording microammeter is plugged into the jack shown in the circuit, thereby disconnecting the indicating meter.

Another possible application is in connection with power system load control, where it may be desirable to change the loading at a generating station automatically in response to extremely slight changes in the generated frequency. Here suitable relays would replace the meter.

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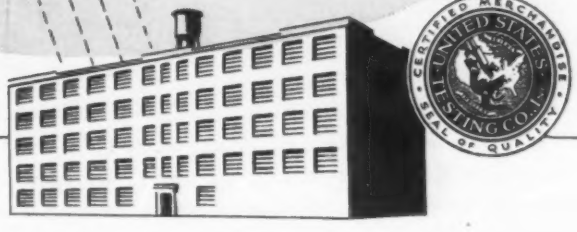

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Supersonics in Biology

SINCE THE ORIGINAL studies of Ward and Loomis, many workers have applied supersonic waves to biological research. In most cases on ordinary flat quartz crystal has been used, the crystal being excited to vibration by r-f power at its natural frequency. It has been found that most cells are rapidly destroyed and small animals killed by exposure to these vibrations.

The forces produced by supersonic vibration vary in direction and magnitude over the surface of a cell of ordinary size, producing a tearing effect. Unfortunately, bacteria in general are so small that they are affected by the wave as a unit, so that it is very difficult to kill them in this manner.

A method for focusing the sound, originated by Grutzmacher, has been applied to biological materials by J. G. Lynn, R. L. Zwemer, A. J. Chick, and A. E. Miller, who report their results in *The Journal of General Physiology*, 26:179-193, 1942. They use a round concave quartz crystal, 5 cm in diameter, curved to focus at a point 5.5 cm from the crystal surface. About 150 times as much supersonic energy is concentrated at the focal spot as at a similar spot near the vibrating plate. The crystal resonates at 835 kc, and is energized by connection to the plate circuit of an r-f amplifier having an input up to 500 watts. The oscillator crystal is variable from 834 to 836 kc, so exact and stable tuning can be obtained.

The object of the study reported was to project a beam of focused ultrasound into tissue blocks and into the tissues and organs of experimental animals, producing a maximum change at the point of focus with little change in the tissues traversed before the focus is reached.

Paraffin blocks were used as the first test objects, and the effects studied by observing the melting effects produced in them. Heat dissipation was found to be greater at the focal point than near the crystal, because of the surrounding cool areas. This effect may be minimized by applying a large amount of power for a short time.

The absorptive capacity of beef liver blocks is so great that it was necessary to use full power instan-

photo by courtesy of Mt. Wilson Observatory.

This is a call to the electronics industry of the future.

In a not too distant tomorrow, men will be coming back from battlefields . . . coming out of secret-enshrouded plants to open the doors to this new era . . . to push forward the limits of man's knowledge with the magic of electronics.

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taneously applied in order to produce a well-defined focus of cellular destruction. This destruction is apparently due to the heating effect rather than to the vibration itself, as it is much reduced in living tissues where the circulating blood rapidly dissipates the heat.

An attempt was made to produce focal necrosis in the brain of a cat, with partial success. Temporary behavior changes and blindness could be produced. Edema and hyperemia of the visual cortex affected by the radiation were found at autopsy, while the rest of the brain appeared normal.

The problem for future investigation is to increase the intensity of sound at the focus, without increasing the damage to skin and intervening tissues. A similar problem is met in x-ray therapy, where the beams are applied in several directions, crossing in the region of the tumor. In some cases the tube rotates around the patient, or the patient may be rotated with the tumor at the axis of rotation.

Several interesting suggestions were made as to the means of applying focused ultrasound more effectively. Lower-frequency vibrations would penetrate to the focus with less absorption on the way. A 3-kw r-f generator would permit the application of high power for a short time, producing a maximum effect at the focus as explained above. The use of six 2-in. concave crystals, all focused on a common point, would not only increase the focal effect, but would also spread the base effect over several times the skin area of a single crystal.

The application of this method and modifications of it should produce interesting results in several fields of biology, when material and time for fundamental research are again available.—W.E.G.

• • •

Survey of Luminescence

LUMINESCENT SUBSTANCES are broadly defined as materials capable of emitting light without the simultaneous emission of a sensible amount of heat—which definition applies to fireflies as well as the phosphors which have recently become so important in the field of electronics. Phosphors, however, are generally defined as materials capable of converting various types of

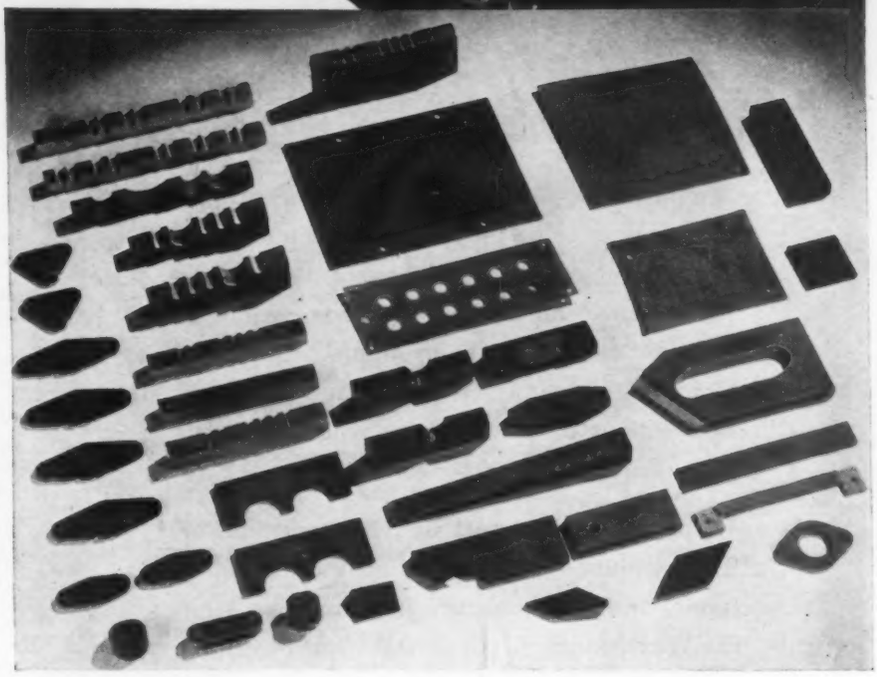
RADIO OPERATOR PHOTOS COURTESY PAN AMERICAN AIRWAYS

LENGTHENING SHADOWS OF PROGRESS

Today, radio communications in civil and military aviation is an important and necessary adjunct that makes possible successful flight operations. Yet, it is only a short time ago since radio played a secondary role in aviation, because of its being subject to the vicissitudes of weather, altitude and distance.

Radio's importance and dependability might well be considered the ever-lengthening shadow of scientific progress . . . the result of improvement, research and the use of better functioning materials.

C-D rightfully claims a large part in radio's importance to modern flying, because of the steady progress on C-D's part in producing plastics such as Dilecto, Celoron and Dilectene . . . plastics from which hundreds of insulating parts, as pictured, are made . . . These C-D Plastics have been engineered to meet "flying" radio conditions.



C-D products include THE PLASTICS . . . DILECTO—a laminated phenolic: CELORON—a molded phenolic: DILECTENE—a pure resin plastic especially suited to U-H-F insulation . . . THE NON-METALLICS, DIAMOND Vulcanized Fibre: VULCOID—resin impregnated vulcanized fibre: and MICABOND—built-up mica insulation. Folder GF describes all these products and gives standard sizes and specifications.

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Today, the major part of the production of B-L Selenium Rectifiers is being used to fulfill prime and sub contracts in connection with the War program. Fortunately, however, our production facilities at this time are meeting Uncle Sam's needs—*and still have available capacity for additional essential industrial business.*

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invisible radiation into visible radiation.

The entire subject is surveyed by two British scientists, Leonard Levy and Donald W. West, in the January 1943 issue of *Endeavour*. The principal results and conclusions obtained from their many years of specialized study of luminescent substances are described, and explanations for fluorescence and phosphorescence are given in terms of modern atomic physics.

In fluorescence, which is the emission of light only during excitation, the electron is supposed to be raised from a lower or filled band in the lattice to the conduction band by the absorption of radiation. The activator supplies electrons to replace those excited from the lower band. Emission of light takes place when the electron falls from the conduction band to the impurity band.

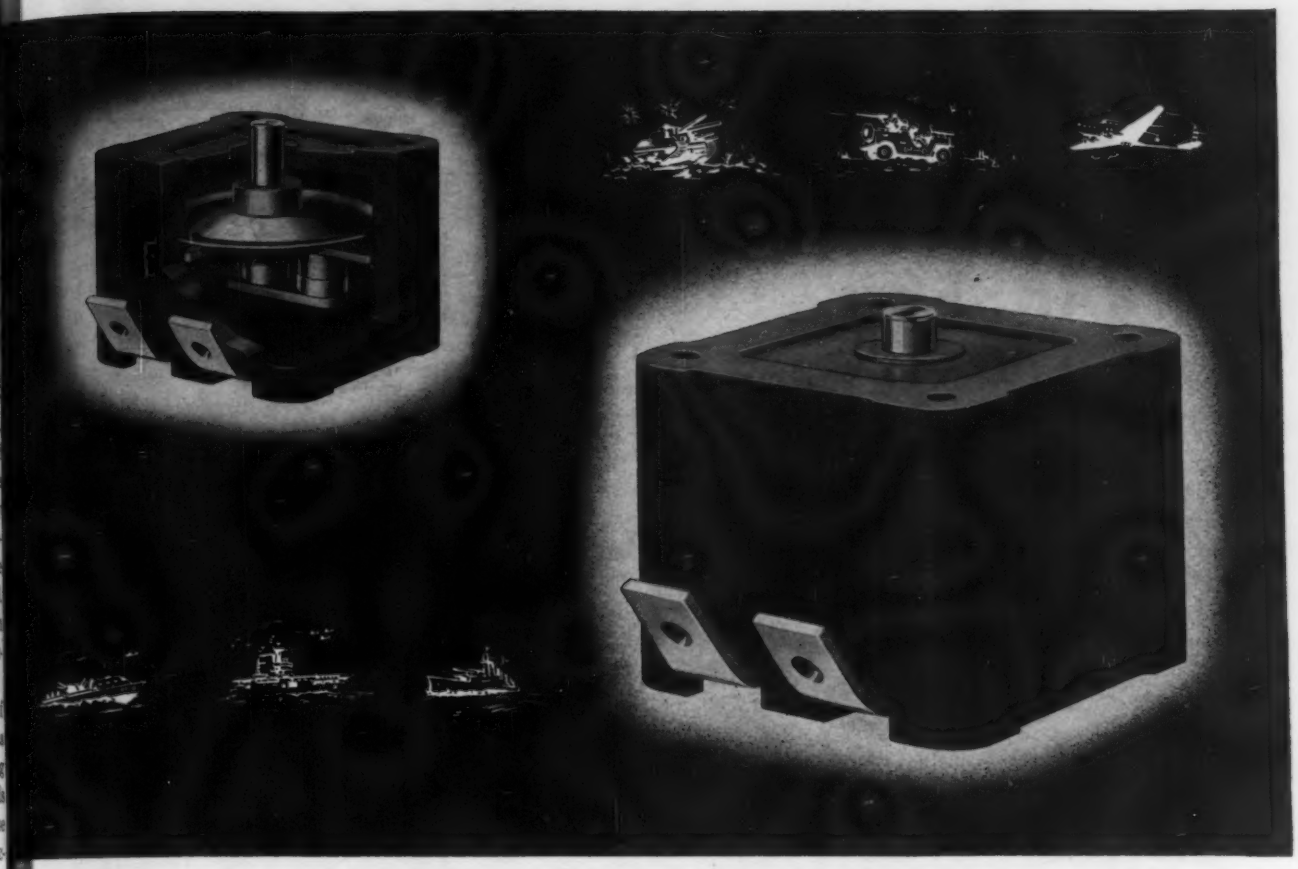
Phosphorescence, the emission of light after incident radiation has ceased, is explained by postulating the presence of metastable bands (the so-called trapping levels) close to the conduction band. The electrons in the trapping levels can be released only by way of the conduction band, owing to thermal oscillations.

Chemical compositions and practical applications for many types of luminescent powders are given. One table gives the relative responses of different phosphors to different types of excitation ranging from long ultraviolet to alpha rays, while another table gives expected fluorescent intensities obtainable from five common phosphors. This latter table indicates that the cathode-ray scanning spot in a television tube produces in a phosphor of ZnS(Ag) plus ZnCdS(Cu) the enormous intensity of about 6,000,000 equivalent foot-candles, whereas 125 watts of ultraviolet at 3 feet produces only 6 equivalent foot-candles on ZnS(Cu).

• • •

Definition of Electronics

IN A RECENT ADDRESS, Dr. Joseph Slepian, associate director of Westinghouse Research Laboratories, defined the science of electronics as dealing with electrons "which are free in the sense of being substantially at much greater distances from the nuclei of atoms than the radii of the outermost stable orbits



Sealed To Give Switch Contacts Positive Protection Against The Hazards Of Dirt, Dust, Sand And Oil

More than five years ago the Allied Control Company's engineering staff anticipated the need of a sealed switch that would give positive protection to the contacts against the hazards of dirt, dust, sand and oil, the greatest factors in switch failure.

Today thousands of Allied A3 and A5 Sealed Switches are vital components in many of the newest types of aircraft and ground equipment and are giving reliable and dependable operating performances in such theatres of war as Africa, China and Alaska where climatic conditions cause failure of ordinary types of equipment.

The operating characteristics called for in many switch applications are so rigid that every component is micrometer checked and after final assembly all operating characteristics are individually precision inspected to insure dependable, long life operation.

OPERATING CHARACTERISTICS OF ALLIED A3 and A5 SEALED SWITCHES:

CONTACT ARRANGEMENTS
Single pole single throw.
A3 — normally closed, double break.
A5 — normally open, double break.

CONTACT RATINGS
Non-inductive, 50 amperes at 12 and 24 volts DC and 110 volts AC.

OPERATING PRESSURE
1½ to 3½ pounds.

PLUNGER TRAVEL
Travel differential 0.006 to 0.012 of an inch.

OVER TRAVEL
0.050 to 0.070 of an inch at maximum pressure.

VIBRATION
10 G for either horizontal or vertical positions.

WEIGHT
5 ounces.

DIMENSIONS
1-15/16 by 1-15/16 by 1-19/32 inches.

ALLIED CONTROL COMPANY, INC.
2 EAST END AVE. *(AT 79th STREET)* **NEW YORK, N.Y.**
FACTORIES: NEW YORK CITY · PLANTSVILLE, CONN. · CHICAGO, ILL.

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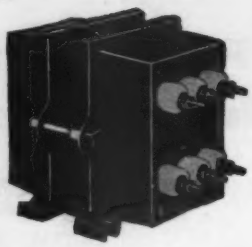
For Electronic Applications



Full details on Newark Transformers, Dry Type or Oil Cooled Distribution Type, in descriptive bulletins on request.

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of the normal atom." This definition is carefully worded to exclude phenomena involving only free electrons in wires, since these free or conduction electrons are never more than a few times 10^{-8} cm from a nucleus. In electronic devices such as radio tubes, the free electrons in the vacuum are usually more than 10^{-4} cm away from any nucleus.

On this basis, a simplified definition of electronics would be "the science which deals with devices in which current flows through a vacuum or gaseous space". Electronics then deals with the means for setting the electrons free in space, the properties of the free electrons, the effects produced by free electrons on other matter, the ways in which free electrons lose their freedom, and the vacuum tubes, x-ray tubes, phototubes, fluorescent lamps, neon signs, ultraviolet lamps, thyratrons, ignitrons and other commonly accepted electronic tubes which depend on true free electrons for their operation.

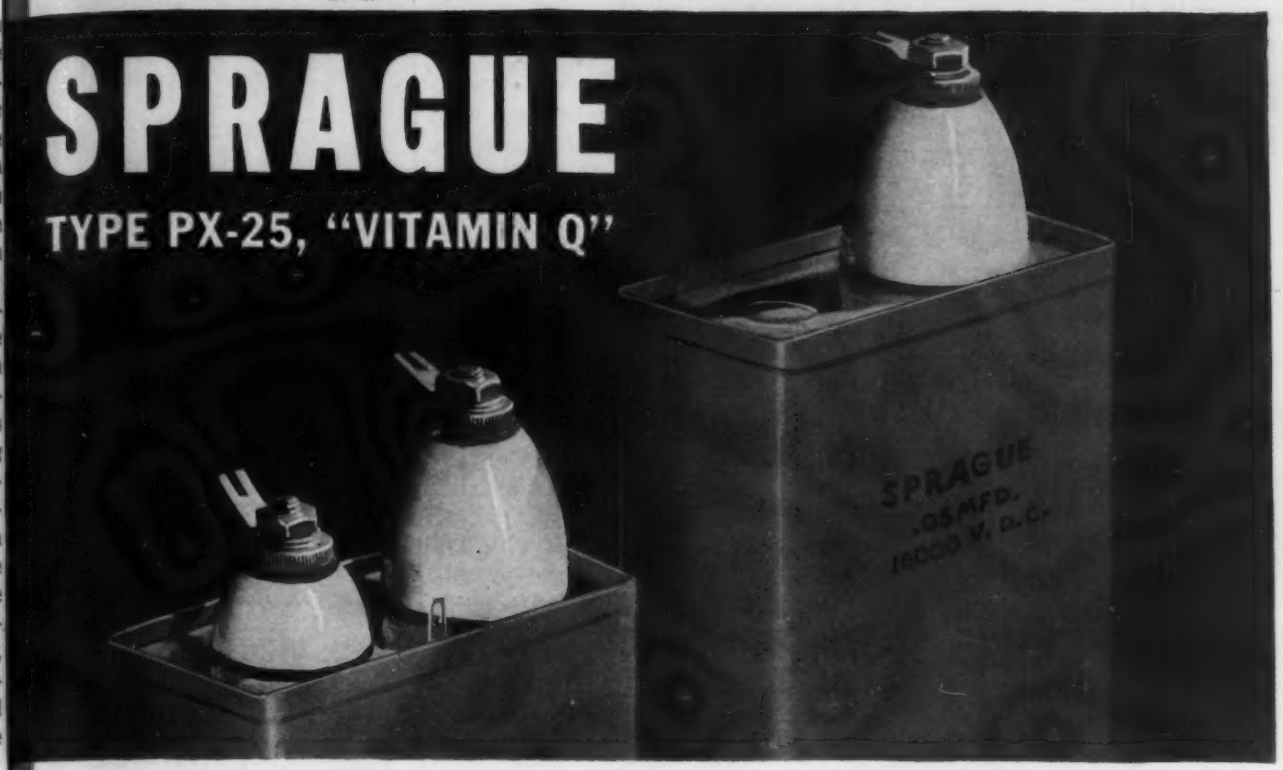
Dr. Slepian points out, however, that this definition unavoidably includes such devices as spark plugs, electric arc welders, electric arc furnaces, spark gaps in lightning arresters, and other apparatus involving electric arcs. He believes these should be accepted as truly electronic apparatus rather than attempt to modify the definition so as to exclude such familiar devices.

Continuing, Dr. Slepian defines electronics engineering as "the applied science of electronics, dealing with the development, design and application of electronic apparatus."

• • •

Making Oscillographs Produce Dotted-Line Tracings

THE USE OF WIRE SCREENS of varying mesh placed in the path of an oscillograph light beam to distinguish between several tracings superimposed on the same film or paper is suggested by R. W. Ahlquist in his paper "Marked Oscillograph Tracings" in the March 1943 *General Electric Review*. The screens may be so mounted that they may be turned out of the beam path when not in use. The larger the mesh of the screen, the longer will be the dashes in the resulting trace. Several examples are given in which properly marked traces facilitate comparison of instantaneous values of recurrent values.



HIGH VOLTAGE PAPER CAPACITORS

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Sprague has the answer to the problem of finding paper capacitors that will handle high voltages at high temperatures.

Typical of many other Sprague developments, these Type PX-25 units, with their exclusive "Vitamin Q" impregnant, have proved their dependability under the most rigorous war conditions. Voltages now available run from 5,000 to 15,000 volts and ambient temperatures are on the order of 110° C. Used at low and ordinary temperatures, these capacitors give a tremendously increased safety margin over the ordinary commercial types.

ARMY E NAVY

Sprague engineers welcome the opportunity to cooperate in solving your capacitor problems. An exceptionally broad background of engineering experience in designing and producing dozens of highly specialized capacitor types for ultra-exacting war uses is freely at your disposal.

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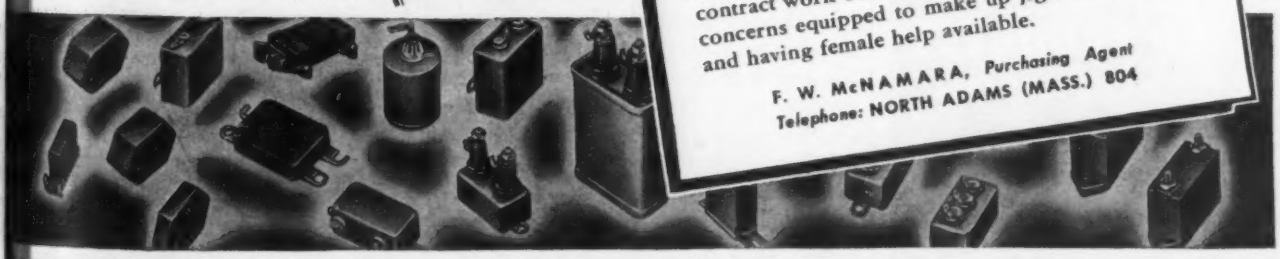

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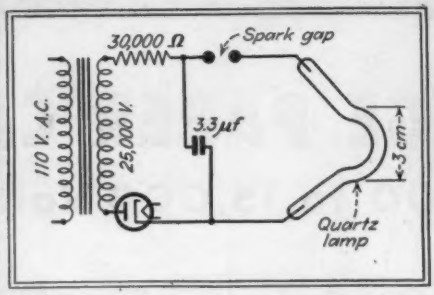
Ultraviolet Flashes Stimulate Living Cells

STIMULATION OF CELLS by intense flashes of ultraviolet light is reported in the *Journal of General Physiology*, 25:431-444, 1942 by E. N. Harvey, Princeton Physiological Laboratory. The source of the light is a quartz sterilamp made by Westinghouse, through which is suddenly discharged a 3.3-μf condenser at high voltage by the breakdown of an air spark gap in series with the condenser, as shown in the diagram.

The usual setting of the spark gap was 6.1 mm, breaking down at 21,000 volts, and producing a flash with an electrical energy input of 728 joules. Lower voltages with less intense flashes are obtained by setting the spark gap closer. The spectrum produced is almost continuous in the visible and near ultraviolet regions, with many lines in the far ultraviolet.



Circuit used to produce an intense ultraviolet flash. The condenser should be rated above 25,000 volts to withstand the peak transformer secondary voltage

The quartz tube of the sterilamp is bent in a ring, 3 cm outside diameter, around a microscope objective and adjusted so that it is about 5 mm from the material on the slide. A copper mosquito gauze is placed between the lamp and the material to eliminate electrical effects on the cells.

It was found that intact frog skeletal muscle and sciatic nerve were insensitive to the flashes, but that single muscle fibers or small groups could be stimulated to contracture in about half of the trials. It is suggested by the author that the ultraviolet was absorbed by the sheath of the nerve or the fascia covering the muscle, or that only a few surface fibers contracted, which would not move the mass of inert muscle. The ultraviolet flashes appear to act directly on the contractile substance rather than on the excitatory mech-

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WIRES drawn to .0005" diameter
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CHARACTERISTICS
Specific gravity of only 2.5 to 2.6. Water absorption S. 1.5-0.001 per cent. Per cent power factor.
S. 1.5 to 60 cycles was only 0.0165. Dielectric constant at 60 cycles was 5.9-1000 KC 5.4.

Makers of electrical and radio apparatus destined for war service are finding in LAVITE the precise qualities called for in their specifications . . . high compressive and dielectric strength, low moisture absorption and resistance to rot fumes, acids, and high heat. The exceedingly low loss-factor of LAVITE plus its excellent workability makes it ideal for all high frequency applications.

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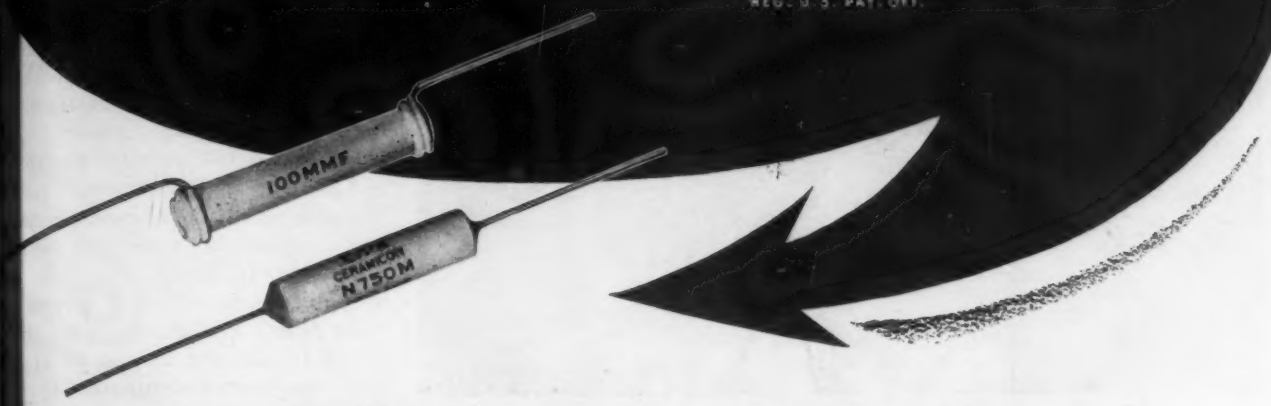


ARE BEING PRODUCED MONTHLY TO PROVIDE COMPENSATION FOR FREQUENCY DRIFT IN ELECTRONIC EQUIPMENT

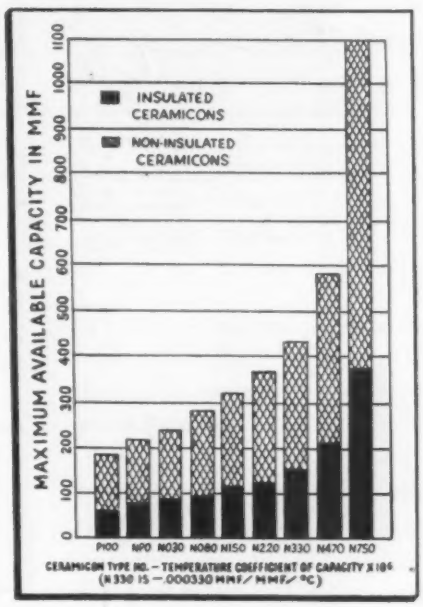
PIONEERED by Erie Resistor more than seven years ago, the demand for Erie Ceramicons has steadily grown because of the increasing need for extremely stable capacitors, and their excellent operating characteristics. As a result of war time requirements, the facilities for producing Erie Ceramicons are being expanded greatly.

Erie Ceramicons are inherently stable in capacity due to the solid nature of the dielectric and the unique method of applying the silver plates directly to the surface of the dielectric. The dependability of this construction has been proven by their use in many types of installations.

Erie Ceramicons are made in nine different temperature coefficients, from + 100 parts per million per °C to — 750 parts per million per °C. Insulated Ceramicons are made in capacities up to 375 mmf; non-insulated units up to 1100 mmf.

The chart reproduced at the right shows the range of capacity and temperature coefficient of Erie Ceramicons. Because of the inherent advantages of insulated type of Ceramicons, this style is recommended where available capacity permits.

For complete information covering operating characteristics of Erie Standard Ceramicons, write for data sheet.



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"TELL 'EM WE COULDN'T DO WITHOUT THE PARTS THEY'RE GIVING UP"

"Yeah, the folks back home are helping us plenty by giving up those radio and communication parts. See—over those hills! There's a bridge there. We just bombed hell out of it—cutting off an enemy tank column. With inadequate communications, we couldn't have done it!"

COMMUNICATIONS are vital in this war of rapid movement—where success demands "co-ordination" of widely dispersed units.

When a swift PT boat gets its radio orders to torpedo an enemy transport . . . when a bomber drops its eggs over a submarine base . . . when an allied tank column, keeping in contact by radio, speeds over Sahara's sands . . . Utah Parts are playing their role in this war of communications.

Soldiers of production build dependability into those parts at the Utah factory. Utah engineers plan it in the laboratories . . . as they pore over blueprints far into the night.

Constantly, research is going on at Utah . . . new and better methods of production are being developed . . . to help keep the ears of the armed forces open. Tomorrow—when peace comes—this research and experience will be reflected in the many civilian products being planned at the Utah Laboratories. Utah Radio Products Company, 837 Orleans Street, Chicago, Ill. Canadian Office: 560 King Street West, Toronto. In Argentine: UCOA Radio Products Co., SRL, Buenos Aires. Cable Address: UTARADIO, Chicago.

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PARTS FOR RADIO, ELECTRICAL AND ELECTRONIC DEVICES, INCLUDING SPEAKERS, TRANSFORMERS, VIBRATORS, UTAH-CARTER PARTS, ELECTRIC MOTORS

anism, producing a response q different from that to electr stimuli.

Ultraviolet flashes were found stop pseudopod protrusion in Amo proteus, oscillatory movement isolated filaments of the blue-gr alga, ciliary movement in the c and protoplasmic rotation in Nit cells. With moderately strong fla the stopping of protoplasmic r tion in Nitella was accompanied b local or propagated action potent

In Vorticella (a microscopic ganism, in appearance much lik bluebell, frequently demonstrated high school biology classes), flash caused the animals to exp and contract several times.

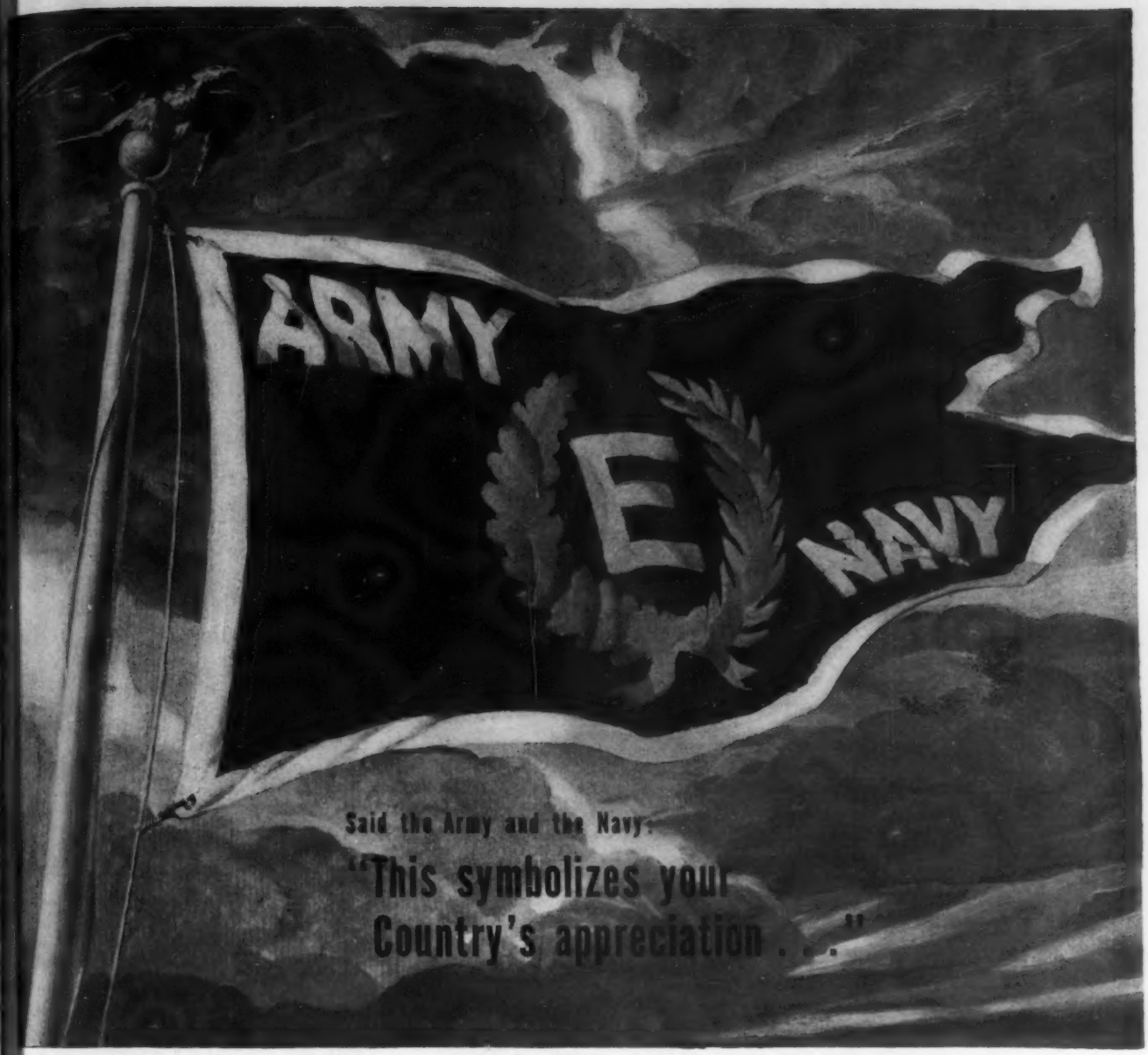
The possibilty of these phenom being caused by something besi the ultraviolet flashes was ruled by interposing either a quartz glass filter. The results were un fected by the quartz, but all of responses were eliminated by glass filter.—W.E.G.

• • •

New Type of Tungsten Cathode for Magnetrons

THE LIFE OF A TUNGSTEN filament a magnetron tube is less than percent of the life obtained fr similar filaments in other thermio tubes, because many of the emitt electrons return to the filament u der the action of the magnetic fi and heat it by bombardment. T process of filament destruction discussed in detail by M. D. Gur vich in the *Journal of Techni Physics* (in Russian), Vol. 11, No. the paper being abstracted in t March 1943 issue of *Wireless En neer*.

The author proposes a new ty of tungsten cathode, in which additional tungsten filament smaller diameter is wound arou the main tungsten filament for p tection from the electron bombar ment and for more equalized te perature distribution. It is stat that magnetrons with this type cathode were operated for up to 2 hours without appreciable damage the cathode and with filament cu rent reduced to less than 50 perce of the conventional value. The ori inal article in Russian suggests th this construction may also be appl able to high-power radio tubes, a gives methods for designing the n type of cathode.



There it flies
The coveted
Army-Navy "E" . . .

We can't tell you
Very much about
The electronics research
That won it . . .

Such matters are
Wartime secrets . . .

But this we *can* say . . .
In the words of
The Army and Navy
This pennant
Represents
"Great accomplishment
In the production
Of war equipment."

Today
Modern radio equipment
Designed and developed
By the Laboratories Division of
Federal Telephone and Radio Corporation
An I.T.&T. Associate
Is helping Uncle Sam's fighting forces
Work together
On land, sea and in the air . . .

Tomorrow
It will help build
A better world
For every man.

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CONSOLIDATED RADIO is proud to be making headphones for the men who fly the skies of the world for the United Nations. The lives of our men—indeed Victory itself—depend upon instant, uninterrupted intercommunications, and CONSOLIDATED RADIO headphones are "delivering the goods."

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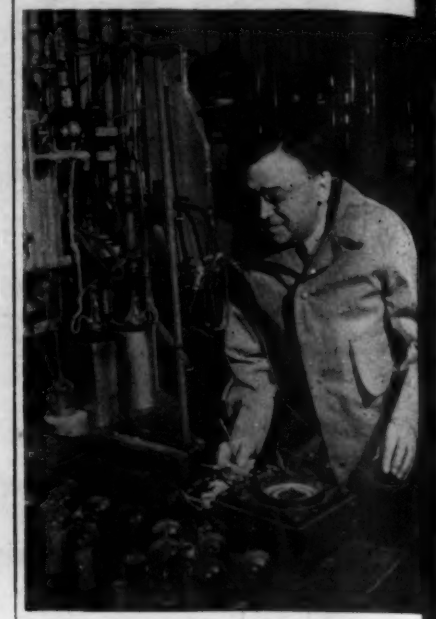
Oxide Cathode Mystery Solved

A PROBABLE ANSWER to the mystery of why electron emission from an oxide-coated cathode is so much higher than from a plain metal cathode is announced by Dr. Harvey C. Rentschler, director of research at the Westinghouse Lamp Division in Bloomfield, N. J. According to him atoms of gas actually dissolve in the crystalline structure of some metals



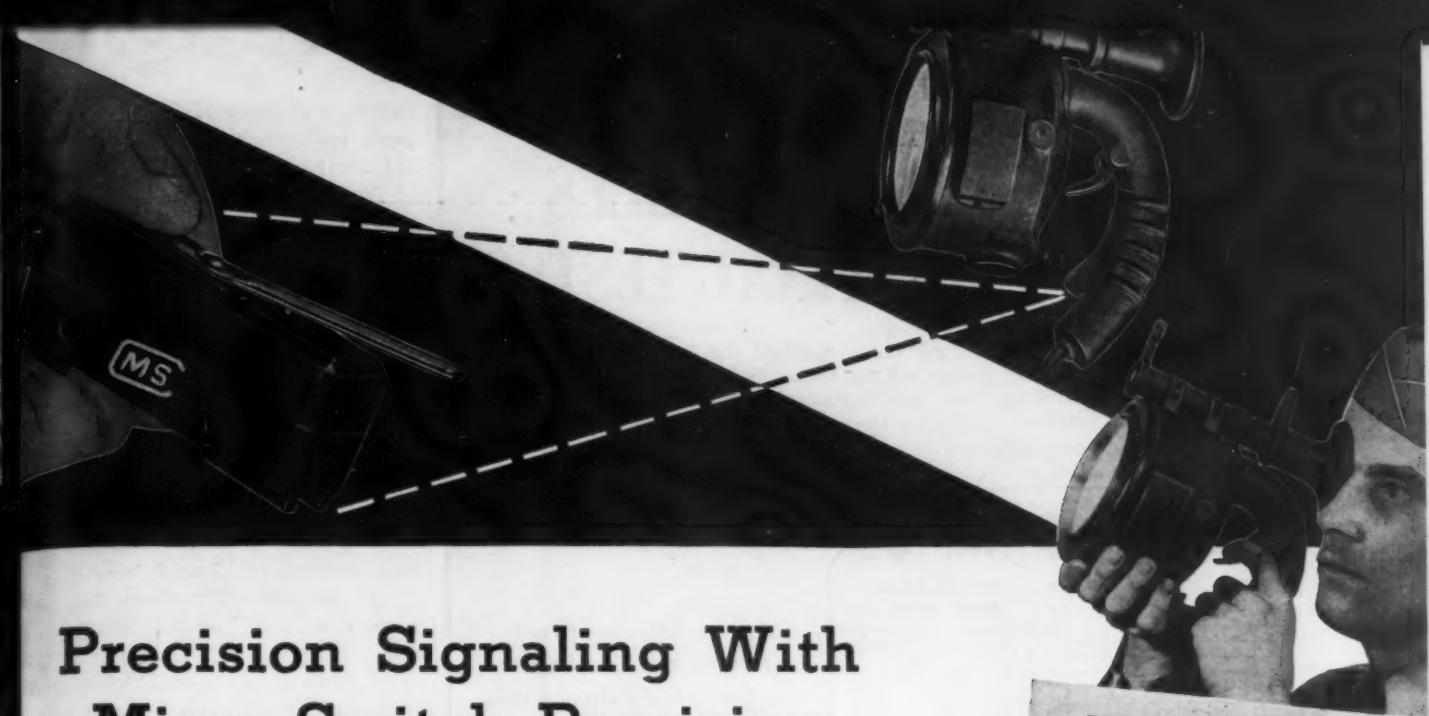
Dr. Harvey C. Rentschler conducting an experiment in which oxygen gas is being dissolved in a strip of zirconium metal enclosed in the glass tube suspended directly in front of him

just as salt dissolves in water. These gas particles then "loosen" the electrons in this structure, causing them to be emitted from the metal more readily when heat or light is applied. With the action understood, the way is opened for development of radio, x-ray and power tubes requiring less filament current for heating purposes and hence having longer life.

• • •

Survey of Problems in Taking X-ray Movies

AN EXCELLENT SHORT survey of x-ray cinematography is given in the Dec. 26, 1942, issue of *The Lancet*. Many radiologists have attempted to perfect cineradiography since the beginning of the present century, when both x-rays and cinematography were in an early stage of development. Despite the manifest clinical advantages of moving pictures of heart action, gastro-intestinal move-



Precision Signaling With Micro Switch Precision

The Aldis type Portable Signal Lamp, manufactured by the Manhattan Marine and Electric Company, Incorporated, of New York City, is widely used by the air, land, and sea forces of the United Nations. Because an observer, more than 6 degrees off the angle of the beam cannot read the signals, this lamp provides safe communication in daylight, at night, and in mist or fog. It has a safe visibility range up to 10 miles. It is an ingenious combination of a range finder, a light and a tilting reflector.

The Aldis type Portable Signal Lamp permits extremely precise signaling through the use of Micro Switch with a double spring actuator which is fitted into the grip of this lamp. Being small and compact, light in weight, rugged and dependable in operation, Micro Switch assures the necessary operating precision. To quote the manufacturer of the Aldis type Signal Lamp, "We are very pleased with the Switch for this unit."

This is but one of many applications through which Micro Switch is performing vital functions in all equipment going into our war program. Micro Switch is on every fighting front—in machine tools and on production lines; on the surface and underneath the surface of the sea; on land, in the dust and heat of the desert, and in Arctic cold.

If you have a problem of precision switching, you should consider Micro Switch—its precise, fast action—its ability to operate at exactly the same point for millions of operations.

Micro Switch measures only 11/16″ x 27/32″ x 1-15/16″, weighs only one ounce, operates on minute movement and force differentials, and is listed by Underwriters' Laboratories with ratings of 1200 V.A. loads, from 125 to 600 volts A.C. It can be supplied in the Bakelite housing as shown above, or in protective housings—die cast, sealed against oil and water; steel, for machine tool applications; aluminum for aircraft; and heavy cast iron for explosion-proof—all with a wide variety of actuating mechanisms.

Send for These Catalogs

The two catalogs illustrated here will give you the complete details—Number 60 which covers Micro Switch in general, and Number 70 which deals with specific Micro Switches for aircraft.

Micro Switch Corporation, Freeport, Illinois
Branches: 43 E. Ohio St., Chicago • 11 Park Place, New York City
Sales and Engineering Offices: Boston • Hartford • Los Angeles

The trademark MICRO SWITCH is our property and identifies switches made by Micro Switch Corporation.

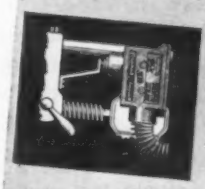
How and For What Micro Switches Are Used

This shows an explosion proof Micro Switch used with a spray gun which automatically cuts out the entire operation of the spraying booth when the gun is shut off.

This illustration shows a Micro Switch with a pushbutton actuator being used as a safety switch in a high tension cabinet door. It is a normally open switch in which the circuit is opened as the door is opened.

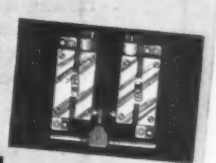
This illustration shows the use of two Micro Switches with spring type plungers to insure safe positioning of material in a punch press or a similar tool.

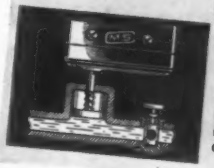
This illustration shows the Micro Switch with a spring leaf actuator serving as a break indicator as used in textile mills or paper mills.



This illustration shows a Micro Switch enclosed in a die cast housing with a synthetic rubber seal, and is being used as a lathe carriage stop.

This illustration shows two steel enclosed Micro Switches which serve as overrun limit switches on a machine tool.





This illustration shows use of a Micro Switch with a spring plunger which is actuated by the pressure of a liquid in a line as the actuating medium.

MICRO SWITCH

Made Only By Micro Switch Corporation . . . Freeport, Illinois

DO CIRCUIT TROUBLES TIE UP YOUR FINAL TESTS?

Thousands of circuits are being checked the Rotobridge way these days. The reason many of the country's largest producers of electronic equipment are installing Rotobridges in an increasing variety of applications is easy to see when you look at a typical Rotobridge inspection tag.

Rotobridge Test Tag

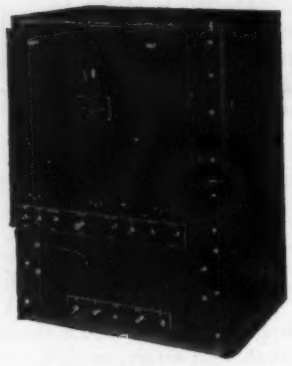
TESTED BY- A.S.B. DATE: 4/22 TYPE: Electronic
FINAL O.K. BY- A.S.B. DATE: 4/24 SERIAL: 129-A

NO.	1	2	NO.	1	2	NO.	1	2	NO.	1	2
1			31			61			91		
2			32			62			92		
3			33			63			93		
4	X OK		34			64			94		
5			35			65			95		
6			36			66			96		
7			37			67			97		
8			38			68			98		
9			39			69		X OK	99		
10			40			70			100		
11			41			71			101		
12		X OK	42			72			102		
13			43			73			103		
14			44			74			104		
15			45			75			105		
16			46			76			106		
17			47			77			107		
18			48			78			108		
19			49			79			109		
20			50	X OK	X OK	80			110		
21			51			81			111		
22			52			82			112		
23			53			83			113		
24			54			84			114		
25			55			85			115		
26			56			86			116		
27			57			87			117		
28	X OK		58			88			118		
29			59			89			119		
30			60			90			120		

FIRST REPAIR BY- A.S.B. 4/23 SECOND REPAIR BY-

An unskilled operator checks on the Test Tag the numbers of the circuits that the Rotobridge indicates are defective. When the defects are corrected, the equipment is tested again and the operator OKs the circuits that have been repaired. If the slate is clean, on goes the "Final OK" and the equipment is ready for a dynamic test.

Simple? – of course. Fast? – you bet. (The ROTOBRIDGE checks a circuit per second.) The way that numbered tag accurately spots the location of circuit defects for the service department will delight every production engineer. In a word, the Rotobridge eliminates wasteful attempts to "prove in" defective equipment in a dynamic test, and speeds the repair of such equipment to an amazing degree.



There is more to the Rotobridge story – it is equally at home testing a single unit in mass production, or a variety of units or sub-assemblies in small quantities. Descriptive literature will be mailed on request, and our engineering department invites your correspondence.

We are pleased to announce our removal to new and larger quarters. After May 1st Telephone: COrtlandt 7-2981

or write to

COMMUNICATION MEASUREMENTS LABORATORY

120 Greenwich Street New York City

ments, etc., none of the methods has been sufficiently simple and practical for routine use.

Two methods have been used to make a radiographic motion picture. In the direct method a long strip of film or single films are moved in front of the part of the body to be radiographed, and single exposures made at short intervals. It is obvious that a large film area must be moved, which makes the method cumbersome and costly, from the standpoints of both film and apparatus. It is also difficult to make the exposures with sufficient rapidity to provide a real moving picture.

In the indirect method a motion picture is made of the image on a fluorescent screen. The light output of the screen is extremely low, making it difficult to record the image photographically. The optical problem has been met very adequately by the development of the Zeiss R-Biotar $f/0.85$ lens.

The luminosity of the screen may be increased by using an x-ray tube with a large target and high plate current, with the disadvantage that the x-rays are poorly focused. There is also considerable danger of exceeding the dosage tolerance of the patient. The focus may be improved by using a fine focus rotating anode tube, and the average plate current and average x-ray output may both be decreased by cutting off the plate supply voltage when the shutter of the camera is closed.

The use of highly sensitive film in the camera is customary, but has the disadvantage that it is coarse grained and produces pictures lacking in detail. Jany and de Castro of Brazil report that they have a method of hypersensitizing fine grain film without increasing the size of the grain. They combine the action of mercury vapor with "several amalgams", but do not describe the process in detail. By hypersensitizing coarse grain fast film they state that they can take slow motion pictures of the heart at 64 frames per second.

According to Lloyd E. Varden in *Journal of the Biological Photographic Association*, 10:63-70, 1941, the best results with commercial film are obtained by using the Patterson Photo-Roentgen screen and Agfa Fluorapid film. This type of screen has a marked afterglow if excited strongly by x-rays or visible light.

Wherever man goes • • • after the war the two-way radiotelephone will find its place in the industrial, business and social life of all nations. At the moment, Jefferson-Travis equipment, with its many exclusive developments, is being used by United Nations throughout the world. With peace, this remarkable electronic device will once again be yours to know, use and enjoy.

JEFFERSON-TRAVIS

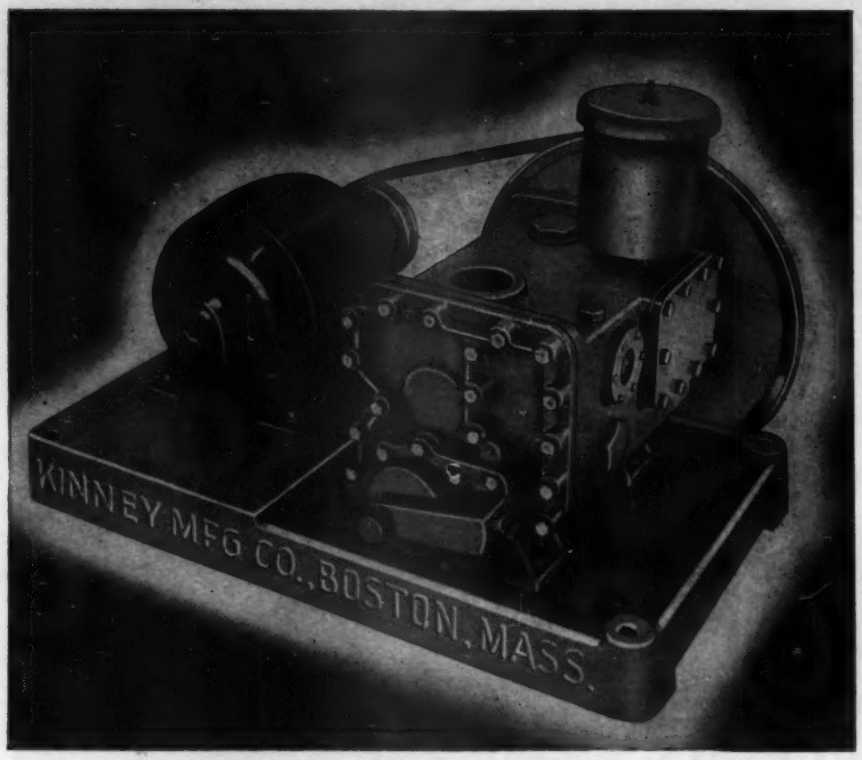
RADIOTELEPHONE EQUIPMENT

NEW YORK • WASHINGTON • BOSTON

KINNEY

COMPOUND DRY VACUUM PUMP

for Unusually High Vacuums



The Kinney Model CVD Compound Vacuum Pump is not a new pump! It was brought out several years ago after extended experimentation and utilizes the working mechanism of the well known Kinney VSD and DVD Vacuum Pumps. To those experienced in the task of creating and maintaining high vacuums with mechanical pumps, the results claimed for this Kinney compound pump were astonishing. Laboratory readings, on an ionization gauge, of 0.5 microns (0.0005 mm.) are regularly obtained and tests have shown readings on the McLeod gauge of better than 0.1 micron. For next higher range of absolute pressures, Kinney Single Stage Pumps are available in sizes from 12 to 680 cu. ft.

Users report splendid results

Since first announced, the CVD pumps have been widely used and results in actual service in a wide variety of uses, especially in the lamp and tube field, have been excellent. For many services, the final vacuum produced by these pumps is so high that they have replaced mercury vapor pumps with gratifying results both as to production times and operating expense since cold traps are eliminated and the pumping system simplified.

Write for this real "tell-all" bulletin

Bulletin 18 contains complete descriptions, capacity and dimension tables, and efficiency curves covering all Kinney High Vacuum Pumps . . . includes a valuable section giving formulas for determining correct pump sizes—address any office listed.

KINNEY MANUFACTURING CO.

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which may last as long as a half hour. The afterglow can be stopped by exposing the screen to deep red or infra-red radiation. As used in x-ray cinematography, the afterglow is not sufficient to have a photographic effect. L. Varden's article contains a good bibliography, and a tabular summary of methods used in both cineradiography and single exposure fluorography.—W.E.G.

• • •

Transmission Line Chart

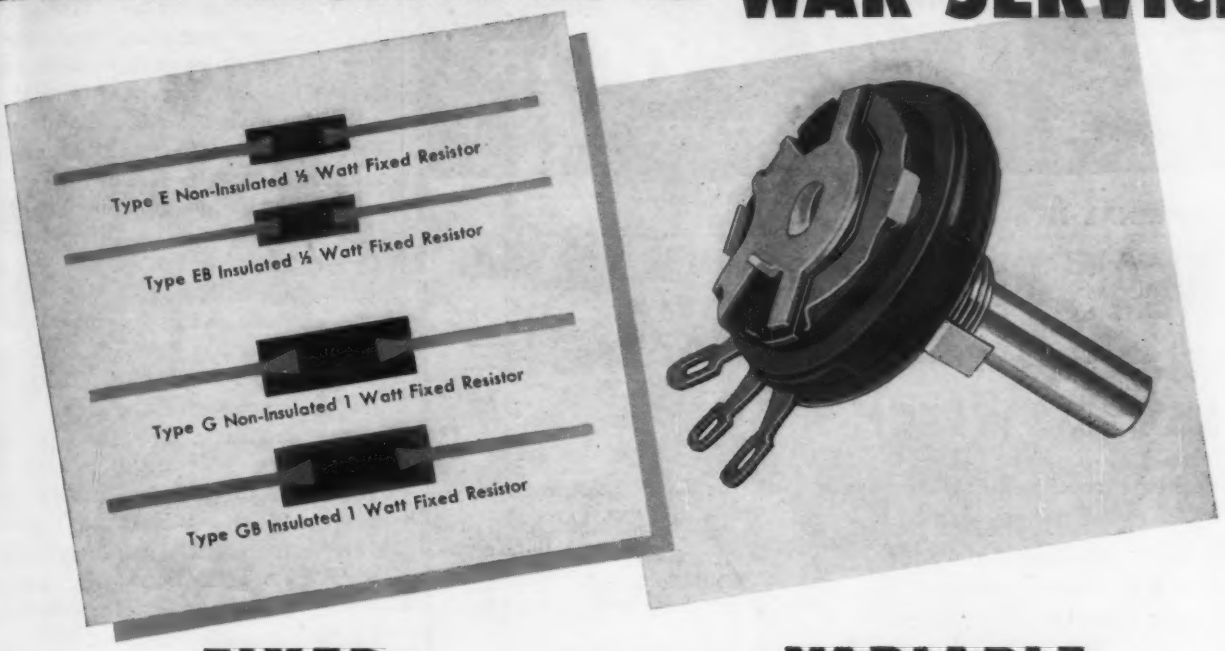
A NOMOGRAPH TYPE of chart from which the attenuation of both two-wire and coaxial transmission lines can be obtained quickly and directly has been developed by J. McG. Sowerby, and is presented in the Feb. 1943 issue of *Wireless World*, a British publication. It applies to lines which are long compared to the wavelength involved—at least five times as long. The chart has six scales, namely line length in yards and meters, frequency in Mc and wavelength in meters, two-wire impedance in ohms, coaxial impedance in ohms, wire diameter or coaxial sheath diameter, and power loss in db. Four positions of the ruler are required to give the loss in db when the other factors involved are known. This chart shows that a two-wire line often gives a lower attenuation than more expensive coaxial lines.

• • •

Phono-electrocardioscope

THE INTRODUCTION by G. E. Donovan of a phono-electrocardioscope which permits simultaneous observation of two wave forms associated with the heart while listening to amplified heart sounds is reported in the Dec. 26, 1942, issue of *The Lancet*. The instrument consists of a double-beam cathode-ray tube with a long persistence screen, which permits the simultaneous observation of two phenomena such as the electrocardiogram and heart sounds, electrocardiogram and arterial pulsations, or heart sounds and arterial pulsations. The curves obtained may be recorded photographically. Multiple headphones and a loudspeaker are provided, so that the heart sounds may be heard as well as seen. Headphones have been found to be much more satisfactory than a loudspeaker for this particular application.

RADIO RESISTORS for WAR SERVICE


Type E Non-Insulated ½ Watt Fixed Resistor
Type EB Insulated ½ Watt Fixed Resistor
Type G Non-Insulated 1 Watt Fixed Resistor
Type GB Insulated 1 Watt Fixed Resistor

FIXED

Available in standard RMA values from 10 ohms to 10 megohms

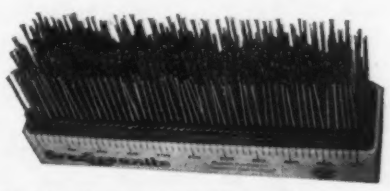
BRADLEYUNITS—These sectional views show the molded homogeneous resistor material, insulation, and imbedded lead wires which make these resistors especially suited for tough war service.

Actual experience in laboratory tests and war service has proved that Bradleyunits function perfectly through a temperature range from −60° to +70° C. Made of inert material, they do not require any special wax impregnation to pass the salt water immersion test. These fixed resistors will sustain an overload of ten times rating for a considerable period of time without failing. Bradleyunits are the smallest—rating for rating—fixed resistors available, the ½ watt unit being ⅜" long and 1/16" in diameter.

The manufacture of A-B fixed resistors is under continuous laboratory control. Uniformity of manufacture assures production of an exceptionally large proportion of resistors with ± 5% tolerance, while the remainder have the standard tolerances of ± 10% and ± 20%. Orders for resistors with ± 5% tolerance are solicited.

The A-B patented lead wire construction provides graduated tempering next to the resistor body and thus prevents sharp bends that would weaken the wire. Write for details today about Bradleyunits and Bradleyometers.

Type E ½ watt non-insulated Bradleyunit molded resistor



This indexed carton of 500 Allen-Bradley Fixed Molded Resistors speeds up production on the assembly line.

VARIABLE

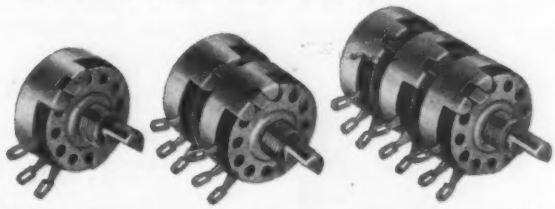
Total resistance values from 60 ohms to 2 megohms

BRADLEYOMETER—Here is the only continuously adjustable composition type resistor (only one inch in diameter) having a rating of two watts with a substantial safety factor.

The resistor material in a Type J Bradleyometer is molded with the insulation, terminals, face plate, and threaded bushing into a single unit. It is not a film, spray, or paint type resistor. During manufacture, the resistor material can be varied throughout its length to provide practically any resistance-rotation curve. Once the unit has been molded, its performance does not change. Heat, cold, moisture, or tough service do not affect it. Long life and quiet operation are assured by the use of a low resistance carbon brush which makes a smooth contact with the surface of the molded resistor.

Bradleyometers not only have a high rating and current carrying capacity, but, due to simple construction and few parts, are exceptionally reliable. There are no rivets, no soldered or welded connections, and no conducting paints. Can be supplied for rheostat or potentiometer uses, with or without a switch.

Sectional view of the resistor unit



Type J Bradleyometer resistor units may be used separately or assembled to give dual or triple construction to fit any particular control need.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee, Wis.

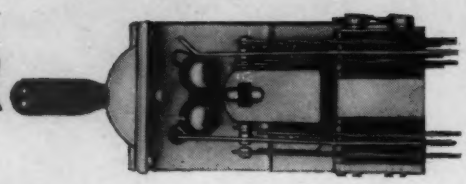
ALLEN-BRADLEY

FIXED & VARIABLE RADIO RESISTORS

QUALITY

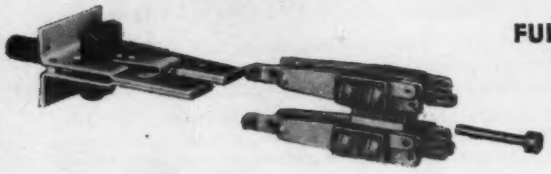
TWO NEW SWITCHES
BY "GENERAL CONTROL"

ORIGINAL NEW
MASTER CAM LEVER SWITCH



Eight years of building cam lever switches developed this new MCL switch featuring:

1. NEW SINGLE BOLT ASSEMBLY
2. NEW STATIC SHIELDING
3. NEW ELIMINATION OF SLIDING FRICTION
4. NEW ALL OVER PLATED SPRINGS
5. NEW GREATER MECHANICAL STRENGTH
6. NEW LONGER LIFE CONSTRUCTION
7. NEW APPROVED MATERIALS
8. NEW LOWER COST



FULLY interchangeable with your present switches. New catalog available showing complete mechanical and electrical specifications. Catalog MCL #20.

NEW
HEAVY-DUTY
FOOT SWITCH

Leaves hands free for other work . . .
Protection against dirt and moisture . . .
New heavy duty adjustable heel rest model

Price $8.00 Single Pole Model

PRICE $5.00
SINGLE POLE MODEL

STANDARD MANUALLY-OPERATED CONTROL SWITCH

Our standard manually-operated control switch is ruggedly designed for operation by foot, knee, hand or elbow pressure. Can be operated at any angle; rubber covered top and bottom to prevent slippage. Connection to the contact unit is made through a standard BX connector. Dimensions of this type MC Switch are 4" dia. x 2⅛" high.

GENERAL CONTROL COMPANY
CAMBRIDGE • MASSACHUSETTS

The frequency range of the sound channel extends up to 1,000 cycles, but this may be divided by means of filters so that any desired murmur or other sound may be differentially amplified. This should be of considerable value in teaching medical students what to listen for in the confusing jumble of sound heard on the first attempt at auscultation. The instrument should also be of use in teaching the correlation of various normal and abnormal sounds with the cardiac cycle, as obtained by comparison with the electrocardiogram.

It is indeed surprising that some company in this country has not produced a double-trace tube of this type, available in England for several years, for which there should be many applications in war research as well as in other fields.—W.E.G.

• • •

Designing Special Slide Rules

MANY EQUATIONS which are tedious of solution even with conventional slide rules can be represented on a special slide rule in such a way that the solution can be had quickly and with reasonable accuracy by one simple setting of the slides and perhaps an addition. Special slide rules are not difficult to construct, and are effective in any field where numerous approximate calculations are made with the same formula.

Detailed instructions for constructing a slide rule for up to four variables are given in a paper by R. C. Odell, appearing in the March 1943 issue of the *Allis-Chalmers Electrical Review*. These instructions apply to any equation in which the relation among the several variables can be reduced to the form "the sum of several terms, each containing only one variable, equals a constant". An example of an applicable equation is

$$B = \frac{34.9 \times 10^5 \times E}{fAN}$$

Although this has five variables, two of them can be lumped into one: $E/N = V_t$ (volts per turn). The equation can then be rewritten as

$$\log A + \log f - \log V_t + \log B = 6.54$$

which is the specified form for placing on a slide rule.

BOEING STRATOLINER

Constant voltage protection all the way

Ask the men who produce planes and the men who pilot them. They'll tell you what vital part *constant voltage* plays in modern aviation. In the sky, it's *constant voltage* on the directional beam which guides the ships through night and storm. In the shop, it's *constant voltage* on the production line which maintains the split-hair accuracy of precision airplane parts.

For the aircraft industry—*and for your own*—SOLA CONSTANT VOLTAGE TRANSFORMERS provide this all-important stabilized power. They stand between costly equipment and destructive voltage fluctuations now common on overloaded power lines. Without supervision they instantly absorb power sags and surges as great as 30%.

For unerring operation of precision tools, and protection of almost irreplaceable instruments and electronic tubes, put SOLA CONSTANT VOLTAGE TRANSFORMERS on duty in your plant. They're built in standard units from 10 VA to 15 KVA capacity—self-protecting against short circuit and without moving parts. Special units can be built to specification.

Note to Industrial Executives: *Find out how Sola "CI" transformers can solve voltage control problems in your operations. Send for bulletin DCV-74.*

SOLA Constant Voltage Transformers

Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-ray Equipment • Luminous Tube Signs Oil Burner Ignition • Radio • Power • Controls • Signal Systems • Door Bells and Chimes • etc. **SOLA ELECTRIC CO., 2525 Clybourn Ave., Chicago, Ill.**

GET THE COMPLETE TECHNICAL RADIO BACKGROUND

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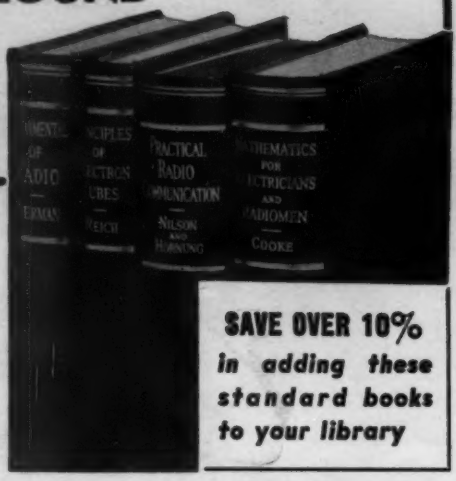

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Full of definitions, descriptions, principles, formulas, data, methods, applications, etc., relating to:

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—amplifiers
—modulation
—detection
—electron tube instruments
—rectifiers and filters
—dynamo-electric machinery and motors
—storage batteries
—radio transmitters
—ultra-high-frequency circuits
—marine transmitters
—low-power telephone and telegraph transmitters
—radio receivers
—antennas
—radio aids to navigation
—television
—acoustics
—control-room equipment and operation
—direct-current electricity and magnetism
—alternating-current electricity
—mathematics for electricians and radiomen
—etc., etc.

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2213 pages, 1332 illustrations

In two of these books widely-used advanced engineering texts have been abridged, to cover the most fundamental aspects of tubes and circuits and their applications, but in the simplified form suited to introduce the man of limited radio and electrical training to these subjects. Another volume further applies these fundamentals to practical communication apparatus, completing a view of radio with which you can solve the technical problems met in a wide variety of situations. The fourth book gives you, at the same time, a progressive command of the radio and electrical mathematics, from arithmetic to advanced principles necessary in using the formulas and computations of advanced technical work.

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Baird Develops Electronic Color Television Receiver

THE 600-LINE COLOR television system announced in 1941 by John Logie Baird employed two rotating color filters at the receiver. Realizing that any moving parts in a television receiver constitute a real drawback, Baird has now developed a similar two-color system which uses stationary color filters and has no moving parts.

Two images are produced one above the other on the screen of the cathode-ray tube in the receiver. Two lenses, one covered with an orange-red filter and the other with a blue-green filter, are placed in fixed mountings one above the other so that each lens is directly in front of one of the images. These lenses project parallel beams onto a larger lens (having twice the diameter of the filter lenses), and the large lens in turn projects the two colored images on the receiving screen as a single image with the two colored components superimposed.

• • •

VIBRATING TABLE

A table, vibrated mechanically, has been designed to save inspectors the tedious task of picking up incandescent lamp bases individually to check both sides for possible flaws. The bases can now be turned over automatically as they jiggle down the sloping table which is kept vibrating by a motor underneath. Key point in the machine is the series of "turnover tubes" across the center of the table which consist of spiral strips that turn the bases upside-down. This table enables employes at the Westinghouse Lamp Div., Belleville, N. J. to inspect metal bases for lamps 400 percent faster than was possible by former methods

High Altitude
OIL-FILLED CAPACITORS

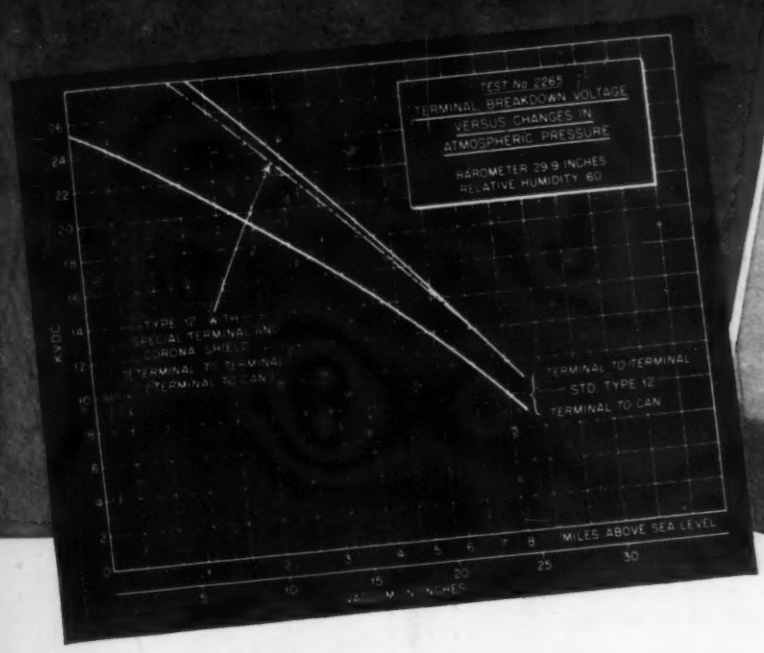

Photo Courtesy of Bell Aircraft Corp., makers of the famous Airacobras.

● Type 12 is a standard Aerovox capacitor. Exclusive Hyvol dielectric oil. Special ceramic insulators on ribbed cap, for ratings up to 7500 v. D.C.W.

At high altitudes encountered in aircraft applications, however, things do happen. While Hyvol maintains the effective capacitance even at sub-zero temperatures found high above the earth, the terminal breakdown voltage drops rapidly in the rarefied atmospheres.

To meet such conditions, Aerovox engineers redesigned the terminals of Type 12. One terminal became a short screw post. The other, a tall ceramic insulator with corona shield at top. Result: minimized surface leakage; minimized corona losses; greatly stepped-up breakdown voltage at high altitudes. The chart tells the story.

Ingenious revisions and adaptations of standard Aerovox types, such as this, are meeting unusual requirements —quickly, fully, economically.

Write for latest Transmitting Capacitor Catalog. And try A.A.E.* on that tough capacitance problem.

*Aerovox Application Engineering

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EDITORIAL REPRINTS

NEW WORLD OF ELECTRONICS . . . Reprints of this symposium from the March 1943 issue contain articles on the application of electronics to telephone, telegraph, radio and military communications; applications of electronics to welding control, induction heating, facsimile and photograph transmission, television, motor control, geophysical prospecting, industrial control problems, research, medicine etc., etc.

This 100-page book is useful for executives and engineers wishing to know what electronics offers American industry in speeding up war production and as a profitable post-war business. Each article is by an expert.

Prices, 1 to 50 copies, $1.00 each; 50 to 100 copies, 85 cents each; 100 copies and more, 75 cents each.

●

UHF TECHNIQUES . . . Last call for this 64-page book on the new science of ultrahigh frequencies. Widely used by Signal Corps, U. S. Air Corps, U. S. Navy and pre-service schools. Individual articles are "Electrical Concepts at Extremely High Frequencies," "Radiating Systems and Wave Propagation," "Generators for U-H-F Waves," "U-H-F Reception and Receivers," "Wide Band Amplifiers and Frequency Multiplication," "Measurements in the U-H-F Spectrum," "Applications of Cathode-Ray Tubes," "Wave Form Circuits for Cathode-Ray Tubes."

This is a final reprinting; paper scarcity makes impossible any further restocking. Price 50 cents each for single copies or 35 cents each for 26 or more.

●

ABBREVIATED EDITION . . . A shortened edition of the UHF Technique symposium containing the articles "Electrical Concepts at Extremely High Frequencies," "Applications of Cathode-Ray Tubes," and "Wave Form Circuits for Cathode-Ray Tubes" is available at 25 cents each.

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Measuring Coil Characteristics

(Continued from page 881)

cillator should be high with respect to that of the coil under test at the resonant frequency, otherwise the *LC* circuit will tend to generate harmonics. It will not then be possible to close the pattern which will assume an irregular configuration, the exact shape being a function of the order and amplitudes of the harmonics. For example, Fig. 8 illustrates the pattern obtained with an oscillator output impedance of 250 ohms as compared to the pattern of Fig. 6 obtained with an output impedance of 5000 ohms. The coil under test in this case had an output impedance of 240 ohms at the resonant frequency. Harmonics may also be excited by the application of too high a voltage.

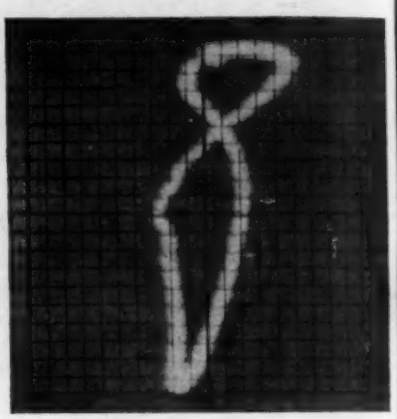


FIG. 8—Effect of using oscillator output impedance low in value, showing generation of harmonics

Distributed Capacitance. The distributed capacitance of a coil may be measured by locating its resonant frequency from the circuit of Fig. 2 although, as Terman,[3] points out, the value obtained in this way will be somewhat smaller than the true value. The results are however usually accurate enough for most engineering applications.

$$\text{Distributed Capacitance } C_D = \frac{\left(\frac{5033}{f}\right)^2}{L} \quad (6)$$

where C_D is in microfarads, and L is in millihenries as measured by the series-resonant method.

It has been the writer's experience at this Laboratory that once the fundamental theory of the foregoing

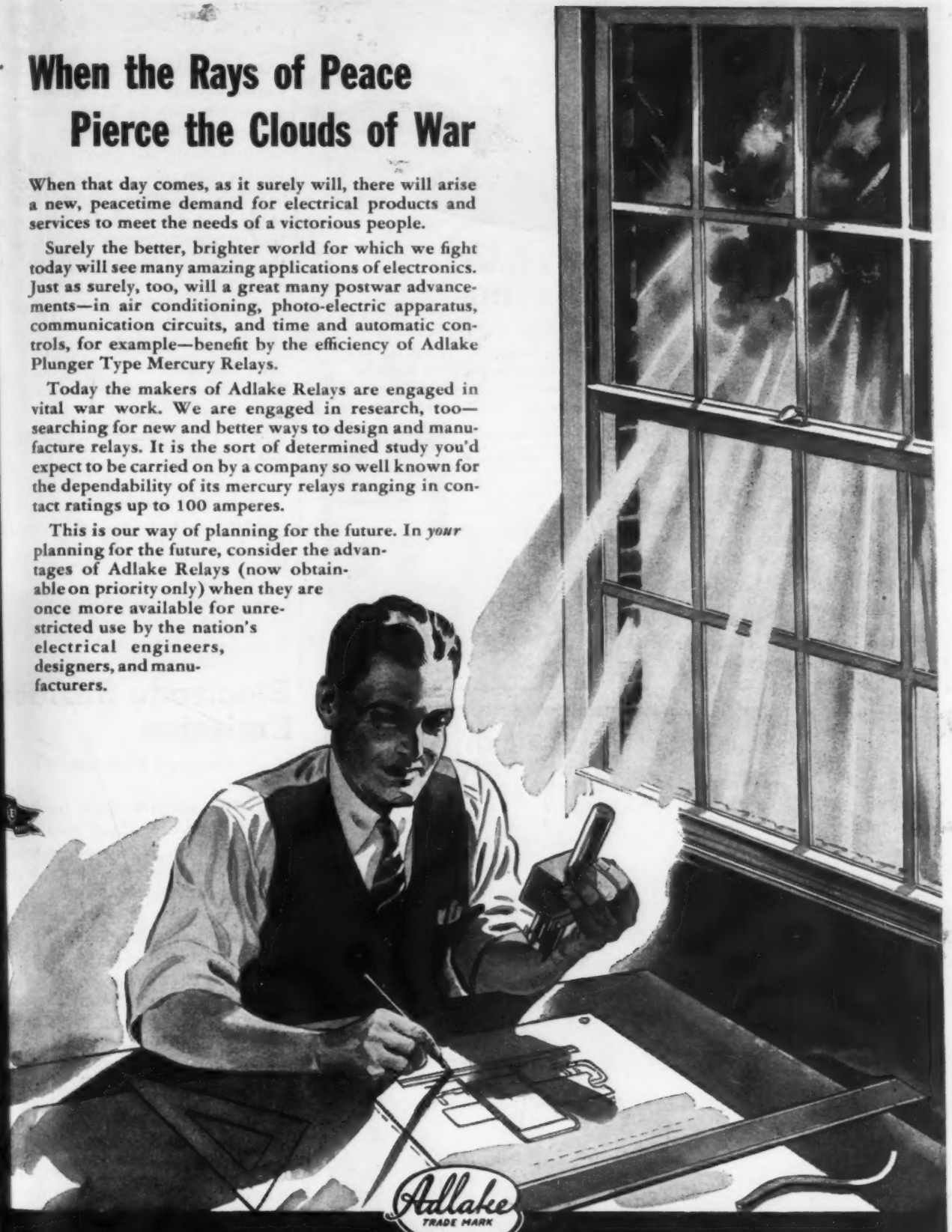
When the Rays of Peace Pierce the Clouds of War

When that day comes, as it surely will, there will arise a new, peacetime demand for electrical products and services to meet the needs of a victorious people.

Surely the better, brighter world for which we fight today will see many amazing applications of electronics. Just as surely, too, will a great many postwar advancements—in air conditioning, photo-electric apparatus, communication circuits, and time and automatic controls, for example—benefit by the efficiency of Adlake Plunger Type Mercury Relays.

Today the makers of Adlake Relays are engaged in vital war work. We are engaged in research, too—searching for new and better ways to design and manufacture relays. It is the sort of determined study you'd expect to be carried on by a company so well known for the dependability of its mercury relays ranging in contact ratings up to 100 amperes.

This is our way of planning for the future. In *your* planning for the future, consider the advantages of Adlake Relays (now obtainable on priority only) when they are once more available for unrestricted use by the nation's electrical engineers, designers, and manufacturers.



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CGS Recorders are mostly channeled to the Army, Navy and Air Forces, but a limited number are available under proper priorities for war plants.

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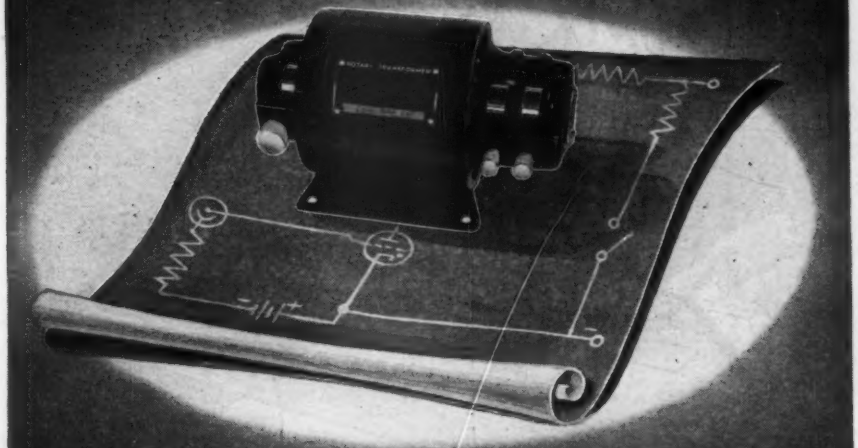

For many years, Carter Dynamotors have been a familiar part of the specifications of leading Communication Equipment Manufacturers, Police Departments, Government Agencies, etc. May we suggest you submit your Dynamotor requirements too, and see for yourself the reason for this recognized preference.

The latest catalog of Carter Dynamotors, Converters, Permanent Magnet Generators and Dynamotors, and special rotary equipment will be sent upon request.

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technique has been thoroughly grasped, the setup time and operating procedure compare favorably with conventional impedance bridge measurements. We frequently use these methods in preference to a bridge, particularly where it is desired to study the progressive effect on the characteristics of a coil of changing frequency and/or influences in its magnetic field. One investigation in particular involved a study of the behavior of layer-wound solenoid coils with plunger cores of different materials and configuration and in one case where the magnetic plunger was shielded by a nonmagnetic sleeve of conducting material. Wave filter elements and other resonant circuits are likewise readily tuned to the desired frequency by this method.

REFERENCES

(1) Watson, F. R., "Sound", p. 58, John Wiley and Sons, New York, N. Y.
(2) Terman, F. E., "Measurement in Radio Engineering", McGraw-Hill Book Co., New York, N. Y.

• • •

Electrode Surface Emission

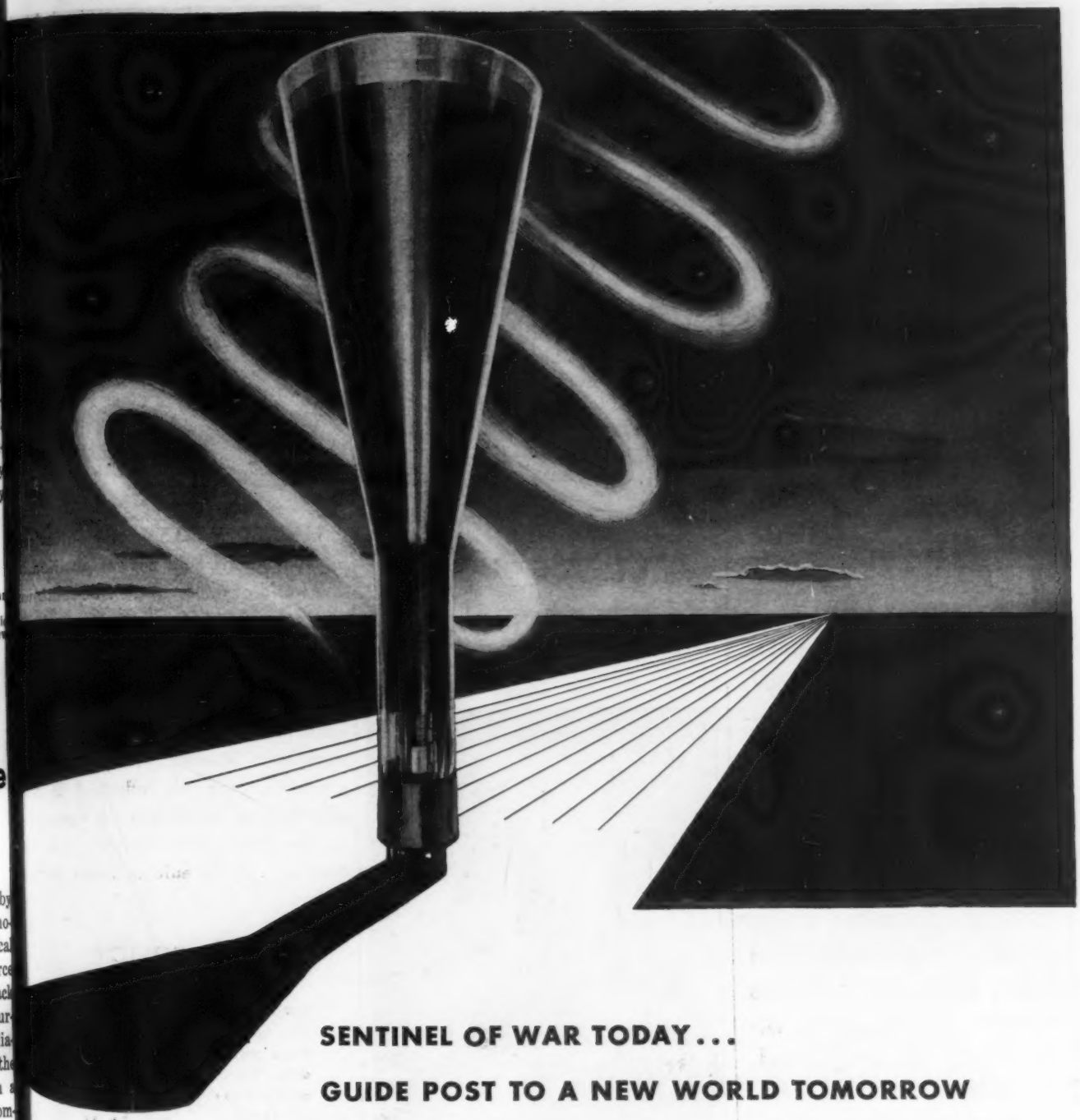
(*Continued from page* 93)

pile. The samples were heated by radiation from a 1000-watt monoplane-filament lamp and spherical mirror, so arranged that the source of energy was about two inches back of the specimen, with the test surface facing the thermopile. A diaphragm was placed between the specimen and thermopile in such a way that the coated surface completely filled the aperture when viewed from the thermopile.

The temperature of each sample was determined by means of a thermocouple spot-welded to the back of the test piece and connected to a Leeds and Northrup potentiometer type temperature indicator. The emissive power was measured at various temperatures ranging from approximately 150 deg. F. to 650 deg. F.

Radiation Data

The data resulting from the examination of fifteen specimens were quite consistent with the Stefan



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Boltzman law and are typified by the accompanying curve.

For purposes of direct comparison at like temperatures, the following emission values were obtained by interpolation.

The tabular data agree remarkably well with the observations made during the use of these materials in radio tube manufacture.

Acknowledgments

The author is deeply indebted to Mr. William F. Little of the Electrical Testing Laboratories who designed and supervised the laboratory tests, and to Dr. L. B. Headrick and Mr. H. T. Swanson of the RCA Victor Division of the Radio Corporation of America for preparing and supplying the test pieces.

• • •

PRODUCTION "MINUTE MAN"

Paul Revere, 28 year old Westinghouse war worker, has won the WPB's Award of Individual Production Merit. His job is to direct the heat treating of tungsten, the metal that forms tough wire filaments in lamps and high power electronic tubes. During the treating process, various chemicals are "boiled" out of the metal and carried away through a system of pipes or vents. The chemical had a tendency to deposit in curved parts of the vents, clogging them and causing a delay while the pipes were cleaned. By redesigning a section of the vent and replacing curved metal tubing with a straight section of pipe, clogged vents and daily delays of time were eliminated. He is a descendent of the famous early-American patriot

It isn't so today...
J. P. is in New York - with his O. K. we can go ahead!
It's O. K. with me - go ahead and start building.
but it will be so tomorrow!

HARVEY - WELLS communications equipment will hold a vital position in the world of *tomorrow* . . . because we are preparing *today*.

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Type RT Adjustable Crystal Temp. Oven Control

Type C-2851 Series, Used as Roughing Controls on Outer Crystal Ovens

Type PM (NAF-1131) Circuit Breaker

NEWS OF THE INDUSTRY

Latest FM developments; Federal alphabet; London electronic news letter; industry personnel changes; E awards; 1942 radio sales data; telegraph merger; Science Talent winners; UHF training

New Army-Navy Preferred List of Vacuum Tubes

A NEW LIST of preferred general-purpose tubes selected jointly by the Signal Corps and the Bureau of Ships was issued as of March 1, 1943, superseding the Army-Navy Preferred List of Vacuum Tubes dated Sept. 28, 1943. The purpose of this list is to effect an eventual reduction in the variety of tubes used in Service equipment. Unclassified tubes (without Navy or Signal Corps designations) to be used in all future designs of new equipments for these branches of the Service must be chosen from this list, unless specific approval of other tubes is first obtained from the Service concerned.

The new list contains 64 types of receiving tubes, 32 transmitting tubes and 14 miscellaneous types. The following tubes constitute additions to the previous list: 9006, 2C22, 2C26, 6C4, 6J6, 6AG5, 6AK5, 3B24, 3R4GY, 73R, 2AP1, 3BP1, 5CP1 and 9EP1. The following tubes were removed from the previous list: 957, 958A, 959, 9004, 955, 7193, 956, 717A and 954.

The Radio Division (formerly the Radio and Sound Branch) of the Bureau of Ships has cognizance over all radio electron tubes used by the Navy Department.

Navy Will Train Engineers for UHF Electronic Work

QUALIFIED ENGINEERS willing to accept a Navy commission can secure a three-month post-graduate course in ultrahigh frequencies either at Harvard or at Bowdoin college, followed by an additional three-month laboratory course at M.I.T., with all expenses paid by the Navy. Upon graduation, these officers will be assigned to responsible engineering positions in connection with research, design, instruction or maintenance of the Navy's ultrahigh-frequency equipment on surface vessels, submarines and aircraft.

Qualifications are a degree in electrical engineering and actual practice of engineering since graduation, or a degree in physics, mathematics or certain other branches of engineering and a sound working knowledge of a-c circuits and elec-

ARMY-NAVY PREFERRED LIST OF VACUUM TUBES—MARCH 1, 1943

RECEIVING TYPES

Filament Volts	Diodes	Diode Triodes	Triodes	Twin Triodes	Pentodes: Remote	Pentodes: Sharp	Rectifiers	Converters	Power	Indicators
1.4	1A3	1LH4	1G4GT	3A5 1291	1T4	1L4 1LN5 1S5		1LC6 1R5	3A4 3Q4 3Q5GT 1299	991
5.0							5U4G 5Y3-GT			
6.3	6H6* 9006	6SQ7* 6SR7*	2C22 2C26 6C4 6J5* 1201 9002	6J6 6SL7GT 6SN7GT	6AG5 6AK5 6SG7* 6SK7* 9003	6AC7* 6AG7* 6SH7* 6SJ7* 9001	6X5GT 1005	6SA7*	6B4G 6G6G 6L6G 6N7GT 6V6GT 6Y6G	6E5
12.6	12H6*	12SQ7* 12SR7*	12J5-GT	12SL7GT 12SN7GT	12SG7* 12SK7*	12SH7* 12SJ7*		12SA7*	12A6*	1629

TRANSMITTING TYPES

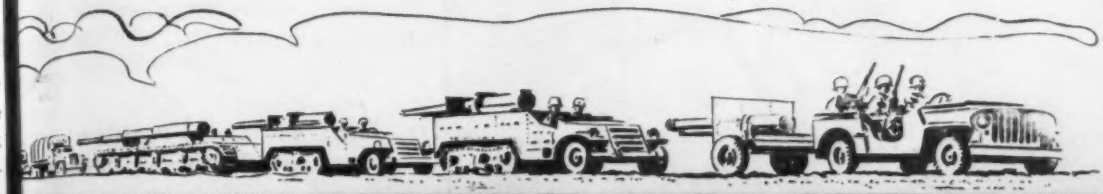
Triodes	Tetrodes	Twin Tetrodes	Pentodes	Rectifiers: Vacuum	Rectifiers: Gas
304TH	807	815	2E22	2X2	4B25
801-A	813	829	803	3B24	83
811	814	832	837	5R4GY	866A
826	1625			73R	872A
833-A				371A	
838				705A	
1626				836	
8005				1616	
8025				8020	

MISCELLANEOUS TYPES

Grid Cont. Rectifiers	Voltage Reg.	Phototubes	Cathode Ray
394-A	VR-90-30	918	2AP1
884	VR-105-30	927	3BP1
2050	VR-150-30		5CP1
C1B			9EP1
C5B			

* Where direct interchangeability is assured, "GT" and "L" counterparts of the preferred metal tubes may be used.

MECHANIZE
Your Screw Driving Army



PHILLIPS SCREWS PERMIT FAST DRIVING METHODS!

Like our fast-moving fighting forces, your screw driving army can now be mechanized to set new speed records on the assembly line.

You can have the advantages of power or spiral driving on almost any job . . . by adopting Phillips Recessed Head Screws. Automatic centering of driving force in the Phillips Recess eliminates the driving troubles that often make fast driving methods impractical. Fumbling, wobbly starts . . . slant-driven screws . . . broken-head screws . . . dangerous skidding of driver points . . . all are forgotten problems in plants that use screws with the Phillips Recessed Head.

Even "green hands" can do fast, skilled work. Savings of 50% in driving time are common. Such man-hour savings are important to the war effort, since so many workers in the average plant are driving screws.

They cost less to use! Compare the cost of *driving* Phillips and slotted head screws. You'll find that the price of screws is a minor item in your total fastening expense . . . that it actually costs *less* to have the many advantages of the Phillips Recess in your assembly work.

KEY TO FASTENING SPEED AND ECONOMY

The Phillips Recessed Head was scientifically engineered to afford:

Fast Starting – Driver point automatically centers in the recess . . . fits snugly. Screw and driver "become one unit." Fumbling, wobbly starts are eliminated.

Faster Driving – Spiral and power driving are made practical. Driver won't slip out of recess to injure workers or spoil material. (Average time saving is 50%.)

Easier Driving – Turning power is fully utilized by automatic centering of driver in screw head. Workers maintain speed without tiring.

Better Fastenings – Screws are set-up uniformly tight, without burring or breaking heads. A stronger, neater job results.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS SELF-TAPPING SCREWS • STOVE BOLTS

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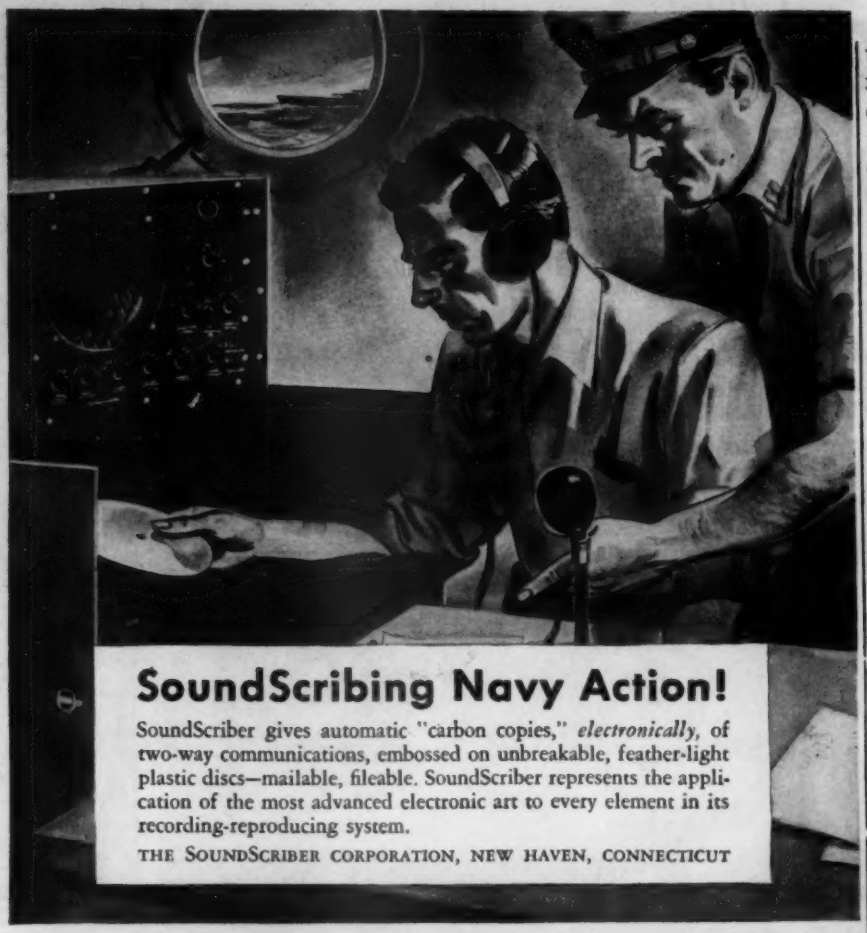
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.



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A-C CALCULATION CHARTS are designed for use by civilian engineers and engineers of the armed forces who operate in the electrical—communication—power—radio—vacuum tube—telephone—and in general, the electronic field. Invaluable for instructors as well as students, and also administrative officers who check engineering calculations.

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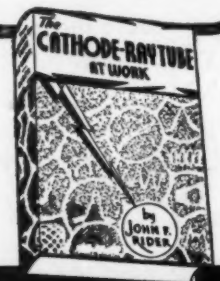
The Cathode Ray Tube at Work is the accepted authority on the subject. The cathode ray tube in the Oscillograph and its application to electronic and industrial work is fully discussed. Profusely illustrated. 338 pages $3.00



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tronics. The usual physical requirements are being relaxed, and applications will be accepted from men up to 50 years of age with slight physical defects which would not interfere with performance of duty. Applications are accepted at any Office of Naval Officer Procurement, located in principal cities throughout the country.

Dr. Hull Elected President of American Physical Society

DR. ALBERT W. HULL, assistant director of the General Electric Research Laboratory, was recently elected president of the American Physical Society. The membership now totals about 4000, including many of the nation's physicists and scientists in fields allied to physics.

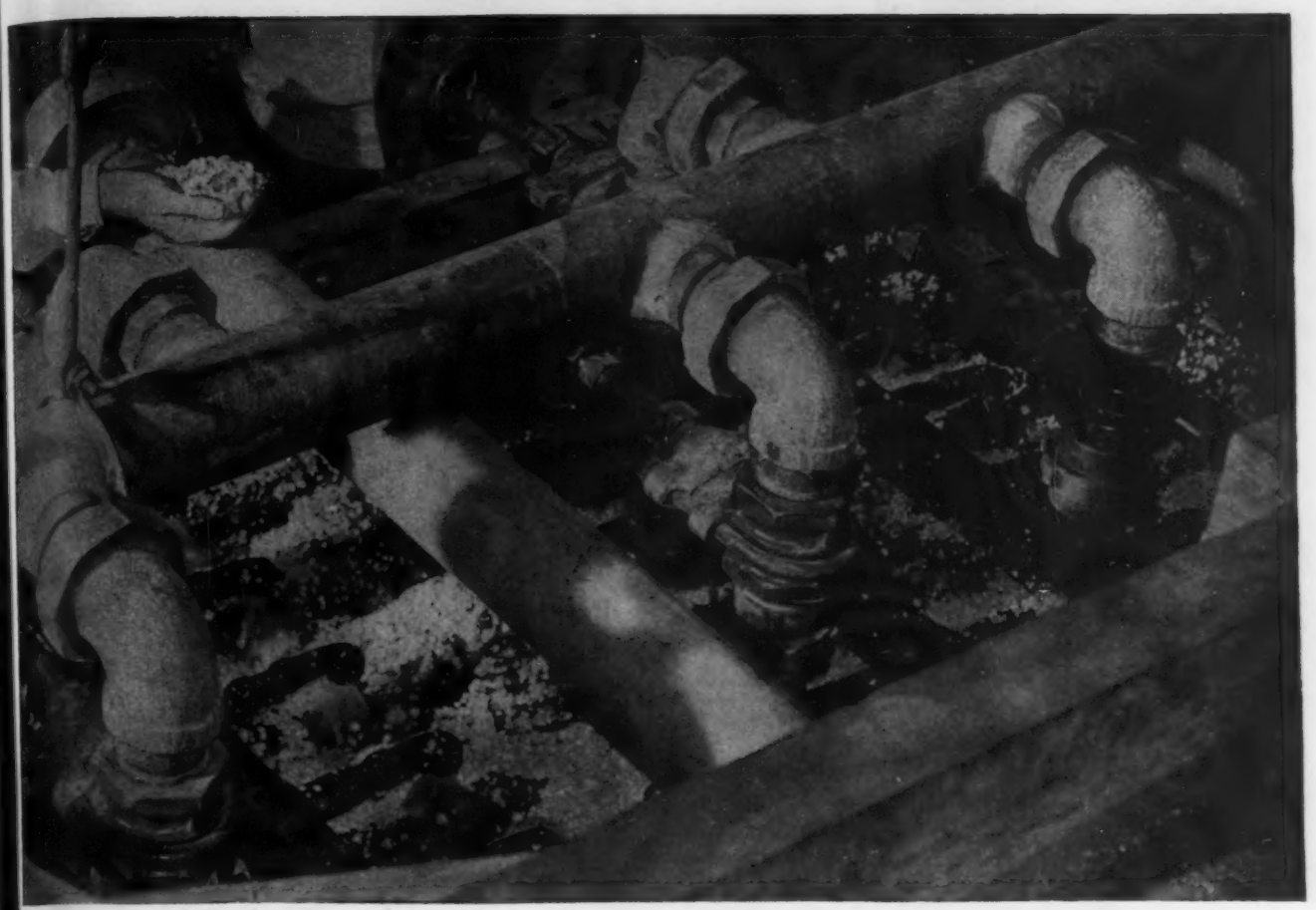
Dr. Hull joined the staff of the Research Laboratory in 1914 after obtaining his PhD from Yale and

Dr. Albert W. Hull, holding one of the many electronic tubes on which he has made important improvements

spending four years as instructor and assistant professor of physics at Worcester Polytechnic Institute. Among his developments are the magnetron, dynatron and screen grid tube. Other honors include the Howard N. Potts gold medal of the Franklin Institute, awarded in 1923 for his work on x-ray crystal analysis, and the Morris Liebmann Prize in 1930 for his work on electronic tubes.

Western Union-Postal Merger

CONSIDERABLE PROGRESS in financial negotiations leading to merger of Western Union and Postal Telegraph



OUT OF THESE FLOCS MAY COME THE FUTURE OF THE WORLD

These white crumbs or "flocs" look very unimportant in themselves . . . but on them may depend the future of the world. They are one of the first stages in the production of synthetic rubber, the most vital material being produced in America today.

Naturally, you are interested in synthetic rubber. But synthetic rubber is only incidental. What is really important is what happens to synthetic rubber after it is actually produced. It is chemistry that makes rubber fit to use, suits it to the task at hand.

United States Rubber Company is the largest manufacturer of rubber chemicals in the world. We have worked with rubber, improved it and broadened its uses for 100 years. Today, all this tremendous fund of knowledge of the chemistry of rubber is being drawn upon to improve synthetic rubber, perfect it for the jobs it must do for the Armed Forces and war industry.

The chemistry of rubber is what determines the final compounding and processing of the flocs of synthetic rubber you see here. They may eventually go into bullet-sealing hose, air ducts, or any one of a score of other parts used in the plane that will blast the last Nip carrier off the sea. They may be made into a tire that will rumble down bomb-battered Unter den Linden. They may go into some essential equipment like a conveyor belt that will keep America's war production line moving at top speed. They might very easily determine the entire course of the war, and thereby the future of the world.

Synthetic rubber, its production, compounding and application to war and industrial uses, is too big a story to present adequately here. There are five basic commercial types of synthetic rubber. Each of them has distinct properties and characteristics. Not a single one is ideal for all purposes.

Deciding which synthetic rubber to select and use for a particular task is an equally big story, a decision that requires expert knowledge and broad range experience.

We have told the story of the five basic commercial types of synthetic rubber, our more than twenty years of experience in working with them, and our twelve years of using synthetic rubber commercially in an interesting, informative booklet for business executives. Please ask for your copy on your regular business letterhead.

UNITED STATES RUBBER COMPANY

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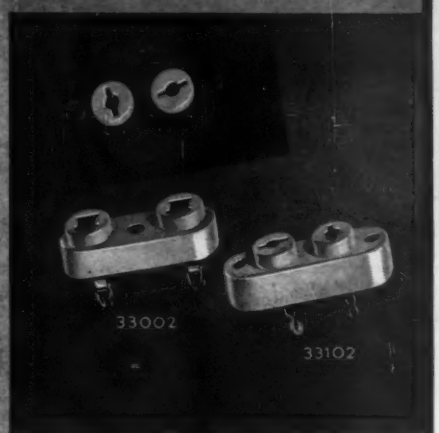
In Canada: Dominion Rubber Co., Ltd.

Designed for Application



33002 and 33102

Crystal Holder Sockets

Designed for Application to effectively and compactly hold either standard or midget crystal holders. Not a clumsy tube socket pressed into service in a makeshift fashion.

Glazed Steatite body with Genuine Amphenol Contacts. Now used on outstanding Army and Navy equipment. Mounts above or below chassis or panel. No. 33002 contacts spaced ¾ inch, No. 33102 contacts spaced ½ inch. Also useful upon removal of contacts as dual thru-bushing, high frequency coil support, etc.

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was reported to an FCC committee in the first conference between top executives of the two companies and a three-commissioner supervisory committee headed by Commissioner George Henry Payne. It is estimated that the minimum time necessary to complete the merger will be close to a year, if agreement can be reached on a satisfactory financial plan and the plan is approved by the FCC as required by the merger Act, then by the stockholders of the two companies. The original legislation is permissive, not mandatory, and hence does not compel consolidation of telegraph companies or operations.

• • •

Four-Wire Cable Provides Seven Signal Corps Circuits

IN A NEW Western Electric-Bell Lab development known as "Spiral-4," a single rubber-covered cable about the thickness of a fat lead pencil provides three telephone circuits and four telegraph circuits. The cable contains four spiralling wires, hence the name. It is made in quarter-mile lengths, the ends of which are fitted with weatherproof connectors. Each length may be snapped to a companion section as fast as the cable can be payed off a moving Signal Corps truck. With amplifiers spaced along the way to compensate for line losses, distances up to 150 miles can be spanned.

Individual messages are combined with carrier currents at the transmitting end as in carrier telephony, and sent through the cable as modulated carrier signals. At the receiving end, electronic equipment removes the carrier signals and guides each signal into its own pair of telephone wires.

Unless equipped with a highly-complex electronic device of special design, an enemy tapping the Spiral-4 cable ahead of the terminal point would hear nothing but an unintelligible mixture of squeaks and squeals.

• • •

Federal Alphabet

FROM BUSINESS WEEK comes the following abridged but still long list of government agencies which are oftentimes known by their initials. With more and more alphabetical agencies cropping up, such a reference list is practically a must for engineers who must follow news of governmental activities.

AAA	Agricultural Adjustment Agency
ANEPA	Army-Navy Electronics Production Agency
APC	Alien Property Custodian
ARA	Agricultural Research Administration
BAE	Bureau of Agricultural Economics
BEW	Board of Economic Warfare
BFDC	Bureau of Foreign & Domestic Commerce
BLS	Bureau of Labor Statistics
BPI	Bureau of Public Inquiries
BWC	Board of War Communications
CAA	Civil Aeronautics Administration
CAB	Civil Aeronautics Board
CCC	Civilian Conservation Corps (in liquidation); also, Commodity Credit Corporation
CCS	Combined Chiefs of Staff
CIAA	Office of Coordinator of Inter-American Affairs
CMP	Controlled Materials Plan (not an agency)
CPRB	Combined Production and Resources Board
DFRRO	Director of Foreign Relief and Rehabilitation Operations
DHWS	Office of Defense Health and Welfare Services
DPC	Defense Plant Corporation
DSC	Defense Supplies Corporation
ERSA	Electronic Research Supply Agency
ESMWT	Engineering Science Management War Training
FBI	Federal Bureau of Investigation
FCA	Farm Credit Administration
FCC	Federal Communications Commission

1942 RADIO RECEIVER SALES BY FACTORIES

(From RCA License Report)

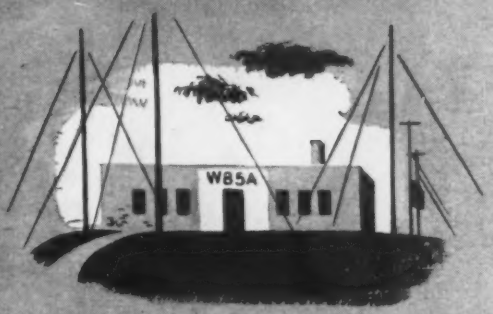
	Units	%	Value *	%
Table Set	1,736,608	40.32	$23,924,300	23.23
Console Set	271,740	6.31	11,084,600	10.77
Portable Set (Battery and/or AC-DC)	573,025	13.30	9,194,900	8.93
Television (Without Sound)	175	.....	9,400	.01
Auto Set	341,424	7.93	5,543,900	5.38
Farm Battery Set (Table or Console)	269,510	6.26	3,967,000	3.85
Frequency Modulation Adapters	7,678	.18	185,700	.18
Elect. Phonos. (Inc. Wireless Rec. Players)	120,649	2.80	1,798,100	1.75
Table Combination Set	379,514	8.81	9,844,500	9.56
Console Combination Set	368,183	8.55	29,657,300	28.80
Radio, Phonograph and Recorder	40,805	.95	3,939,500	3.83
Television (With Sound or Phonograph)	778	.02	78,800	.08
Apparatus Without Cabinets	195,996	4.55	3,728,600	3.62
Sep. Remote or Time Controlled Devices	899	.02	12,100	.01
TOTAL	4,306,984	100.00	$102,968,700	100.00
1941 Total	13,668,515	.....	$234,347,000	.....

* At manufacturers' selling price.

G. E. builds FM's future on these four facts

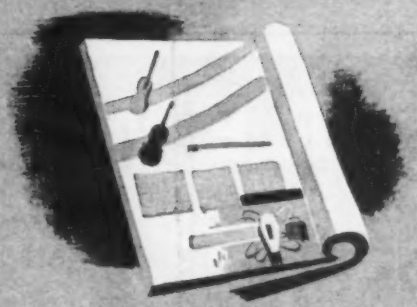
G. E. Builds Both FM Transmitters and Receivers

G.E. is the *only* manufacturer with experience in building the complete FM system — FM broadcasting equipment and FM home receivers. Radio research and volume production for war are yielding new possibilities for further improving FM equipment.



G. E. Has Program and Equipment Experience

Three years of broadcast experience in its own proving-ground Station W85A, Schenectady, will enable G.E. to help new FM stations get started quickly. General Electric's experience also includes equipping more than a third of the 36 commercial FM broadcast stations now in operation.



G. E. is Telling Public the Advantages of FM

A powerful G-E advertising campaign in the nation's big-circulation magazines and the thrice-weekly nation-wide G-E program over C.B.S.—Frazier Hunt and the News—are pre-selling the public on the advantages of FM—and are steadily building an expanding post-war market.

Survey Proves Vast Increase in FM Acceptance

An independent consumer survey reports that: The public already strongly approves FM; 85% call it a definite improvement over conventional broadcasting; present owners of G-E FM receivers are the most enthusiastic of all FM owners! . . . *Electronics Department, General Electric, Schenectady, N. Y.*

TRANSMITTERS

STUDIO EQUIPMENT

ELECTRONIC TUBES

ANTENNAS

RECEIVERS

GENERAL ELECTRIC

160-84-6914

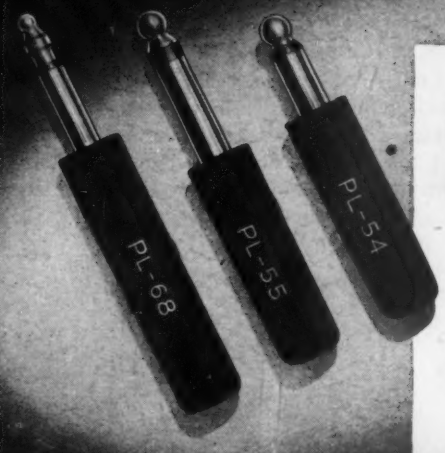
NO OTHER MANUFACTURER OFFERS SO MUCH FM EXPERIENCE

COMPLETE STATION EQUIPMENT

FM · TELEVISION · AM

KENYON TRANSFORMER CO., INC.
840 BARRY STREET, NEW YORK, N. Y.

REMLER
Plugs and Connectors



ARMY SIGNAL CORPS SPECIFICATIONS

- Also PL—PLP—PLQ and PLS Plugs
- M Type Connectors
- M Type Caps
- FT Type Fittings

Quantity Prices Quoted on receipt of Delivery Schedules

Manufacturers of Communication Equipment
SINCE 1918

REMLER COMPANY, Ltd. · 2101 Bryant St. · San Francisco, Calif.

FCIC	Federal Crop Insurance Corporation
FDA	Food & Drug Administration; also Food Production and Distribution Administration
FDIC	Federal Deposit Insurance Corporation
FHA	Federal Housing Administration
FHLBA	Federal Home Loan Bank Administration
FPC	Federal Power Commission
FPHA	Federal Public Housing Authority
FSA	Farm Security Administration; also Federal Security Agency
FTC	Federal Trade Commission
FWA	Federal Works Agency
GAO	General Accounting Office
GPO	Government Printing Office
HOLC	Home Owners' Loan Corporation
IADB	Inter-American Defense Board
ICC	Interstate Commerce Commission
MRC	Metals Reserve Company
NACA	National Advisory Committee for Aeronautics
NHA	National Housing Agency
NLRB	National Labor Relations Board
NRPB	National Resources Planning Board
NWLB	National War Labor Board
NYA	National Youth Administration
OAPC	Office of Alien Property Custodian
OAWR	Office of Agricultural War Relations
OCD	Office of Civilian Defense
ODT	Office of Defense Transportation
OES	Office of Economic Stabilization
OEM	Office of Emergency Management
OLLA	Office of Lend-Lease Administration
OOC	Office of Censorship
OPA	Office of Price Administration
OSFCW	Office of Solid Fuels Coordinator for War
OSRD	Office of Scientific Research and Development
OSS	Office of Strategic Services
OWI	Office of War Information
PAW	Petroleum Administrator for War
PBA	Public Buildings Administration
PRA	Public Roads Administration
PWA	Public Works Administration
PWC	Pacific War Council
PWRCB	President's War Relief Control Board
REA	Rural Electrification Administration
RFC	Reconstruction Finance Corporation
RRB	Railroad Retirement Board
RRC	Rubber Reserve Company
SCS	Soil Conservation Service
SEC	Securities and Exchange Commission
SPARS	Women's Reserve, U. S. Coast Guard (Spar adapted from Coast Guard)
SSB	Social Security Board
SSS	Selective Service System
TVA	Tennessee Valley Authority
USCG	United States Coast Guard
USECC	United States Employees' Compensation Commission
USES	United States Employment Service
USMC	United States Marine Corps; also, U. S. Maritime Commission
WAAC	Women's Army Auxiliary Corps
WAVES	Women's Auxiliary Volunteer Emergency Service (Women's Reserve — U. S. Naval Reserve)
WDC	War Damage Corporation
WERS	War Emergency Radio Service
WMC	War Manpower Commission
WPA	Work Projects Administration (in liquidation)
WPB	War Production Board
WRA	War Relocation Authority
WSA	War Shipping Administration

Scholarships Awarded in Science Talent Search

FORTY HIGH SCHOOL SENIORS shared a total of $11,000 in scholarships as winners of the second annual nationwide Science Talent Search sponsored by Westinghouse and Science Service. These awards were based on the results of a special science aptitude test given to 15,000 students, an essay on the subject "Science's Next Great Step Ahead", and personal and scholarship records submitted by teachers. The 40 leading students in the contest were brought to Washington, D. C., for final examinations and individual interviews to determine the winners of the top awards.

Grand Scholarships of $2400 each were awarded to Gloria Lauer of Ames, Iowa, and Raymond Schiff of

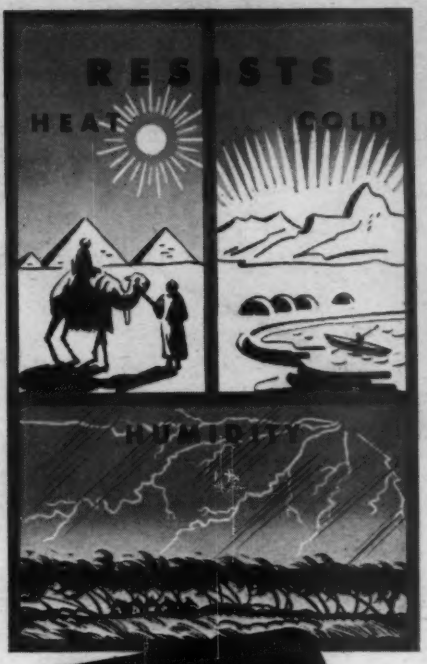
MAGNET WIRE HEADQUARTERS

BARE AND ALL INSULATIONS

SILK COTTON
PAPER FORMVAR
ENAMELED

REA MAGNET WIRE COMPANY
FORT WAYNE, INDIANA

WITH VICTORY AT STAKE THE BEST IS NONE TOO GOOD!



It's Thermatite Treated

Thermador Transformers are Thermatite treated to withstand extreme temperatures and humidity—arid or moist heat—dry or damp cold do not hamper their efficiency. Thermatite is the name of a process of accurate heat controlled vacuum impregnation developed and improved over a period of ten years.

Thermador also manufactures built-in Electric Heaters, Electric Ranges, Electric Water Heaters

THERMADOR
THERMATITE TREATED
TRANSFORMERS

THERMADOR
Electrical Manufacturing Co.
5119 S. Riverside, Los Angeles
"Seven Leagues Ahead"

Gloria Lauer and Raymond Schiff, winners of $2400 Westinghouse scholarships

New Rochelle, New York. The next eight winners received $400 scholarships, and the remaining thirty students were presented with $100 scholarships. The scholarships are provided by Westinghouse as a contribution to the advancement of science in America, and permit the recipients to attend any colleges or universities meeting the requirements of the awarding committee.

Objectives of the search include discovery and sponsoring of boys and girls whose scientific skill, talent and ability indicate potential creative originality warranting scholarships for further development, and encouraging scientifically gifted students to perfect their scientific and research skill and knowledge so they can increase their capacity for contributing to the winning of the war and the peace to follow.

Varioplex Telegraph Patent Is Granted with 107 Claims

THE BASIC PATENT on the varioplex multichannel telegraph system, known to the public as the telemeter system, was granted to Philo Holcomb, Jr. of New York City on March 9, 1943, and assigned to Western Union Telegraph Co. It carries a total of 107 claims covering applications to all types of wire and radio communication circuits. The patent application was filed April 13, 1933.

In the varioplex system, the capacity of the wire or radio circuit is allotted to working channels only, and these working channels are cut out as soon as they stop sending. In ordinary multiplex telegraphy, however, the circuit is equally divided among its connected channels and an idle channel wastes its pro-

INSULINE CORP. OF AMERICA
ICA

VITAL FACTORS
IN OUR GREAT WAR EFFORT!

Electronic Products and Parts are vital factors in our war effort. Insuline is putting vastly increased effort behind the manufacture of these products for the Armed Services:—

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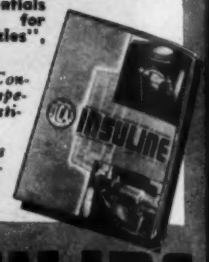
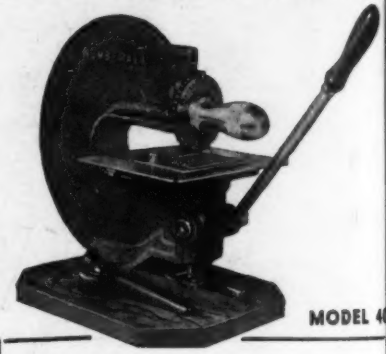
Mfrs. and Contractors: Send specifications for estimates.

Write for this 12-page Industrial Catalog now!



INSULINE
CORPORATION OF AMERICA
INSULINE BUILDING
(36-02 35th AVENUE)
LONG ISLAND CITY, N.Y.

• NUMBERALL •
NUMBERING and
LETTERING PRESS



MODEL 4

Quickly stamps serial numbers and other details on name plates, names and numbers on tags, etc. Can also be furnished for HOT stamping. Write for catalog.

NUMBERALL
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For Continuing Achievement

A STAR FOR WESTON

—evidence that the vital instrument situation rests in good hands!

A star now adorns the ARMY-NAVY "E" pennant awarded to WESTON just 6 months ago . . . the first such pennant awarded in this highly specialized instrument field.

It's a star that has *real meaning*. Because, from the very beginning of our defense period, the responsibility for producing the vast quantities of instruments vital to the success of our country's efforts, has rested largely on the instrument leader.

This star signifies that the responsibility *rests in good hands*. "The men and women of the WESTON Electrical Instrument Corporation," writes the Chairman of the Navy Board for Production Awards, "have achieved a signal honor by continuing their splendid production in such volume as to justify this award . . . indicating their solid determination and ability to support our fighting forces with equipment necessary for victory."

But a great instrument task still remains . . . before victory is ours. So WESTON workers continue reaching for new goals . . . with the same determination, the same painstaking devotion to the quality ideal, responsible for WESTON'S *continuing leadership* in the instrument field.

WESTON ELECTRICAL INSTRUMENT CORPORATION, NEWARK, NEW JERSEY

Sta-Warm SOLDER POTS

ANY TYPE, ANY SIZE, FOR ANY HEATING SPECIFICATION

No. RX-18

No. 647

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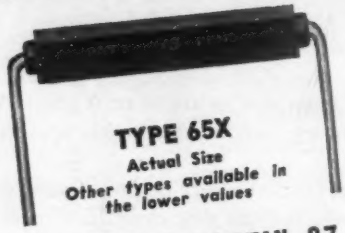
● Whatever your requirements in melting solder and soft metals, they can be fully and most satisfactorily met with a Sta-Warm. Available in either direct-heat, three-heat, rheostat, or with variable thermostatic control, in shapes and sizes that promote the highest efficiency in soldering, tinning and dipping operations. Heat is evenly distributed around the pot. Current consumption is held to a minimum. Let Sta-Warm engineers advise on equipment specifically designed to meet your needs. No obligation.

● Sta-Warm also builds electric heaters for waxes, compounds, glue, pitch, etc. What is your problem?

STA-WARM ELECTRIC CO.
1000 N. CHESTNUT ST. • RAVENNA, OHIO

MOLDED
S·S·White RESISTORS
The "All-Weather" Resistors



TYPE 65X
Actual Size
Other types available in the lower values

RESISTOR BULLETIN 37 GIVES FULL DETAILS . . .

It shows illustrations of the different types of S. S. White Molded Resistors and gives details about construction, dimensions, etc. A copy, with Price List, will be mailed on request. Write for it—today.

They're Ideal **for use in Aircraft and Naval Equipment . . .**

because they retain their values and characteristics under extremes of temperature, humidity and climatic changes. Also because of their noiseless operation and exceptional durability.

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STANDARD RANGE
1000 ohms to 10 megohms.

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HIGH VALUES
15 megohms to 1,000,000 megohms.

ARMY E NAVY

S. S. WHITE
The S. S. White Dental Mfg. Co.
INDUSTRIAL DIVISION
Department R, 10 East 40th St., New York, N. Y.

portion of valuable lane time. Chan ing from multiplex to varioplex h resulted in increases of from percent to several thousand perce in the carrying capacity of a circu depending upon the number of cha nels used and their loading.

All customer channels in a vari plex system feed contacts of a co tinuously rotating switch and ass ciated electromechanical mechanism arranged in such a way that o character or letter at a time taken from each working chann and fed to the single circuit. A sim lar rotating switch at the receivi end of the circuit sorts the chara ters and distributes them to t proper receiving channels in t proper order.

When some of the teletypewrite or sending printers are idle, the r tary scanning switch passes ov their contacts without stopping, that only the active working cha nels share in the useful sending tim of the circuit. The more workin channels there are, the longer takes the switch to send one chara ter from each and the slower is t over-all sending. There is no actu delay on any working channel, ho ever, until the combined load e ceeds the full capacity of the ci cuit. After that, messages beg piling up on the paper tapes at t sending machines, but the only a verse effect is slowing of transmi sions for all working channels un formly.

With this system, then, there no limit to the number of variople channels that can be put on a sing wire or radio circuit as long as t combined load at any time does n appreciably exceed the carrying c pacity of the circuit. Charges a based on the number of characte sent regardless of the time taken send them, since a sender gives its share of the circuit as soon as stops sending.

Stations Change Call Letters

WITH FCC PERMISSION, statio WJSV in Washington, D. changed its call letters to WTOP April 4, 1943. The purpose of t change is to help newcomers to r member the call letters and remem ber that the station is at the "t of the dial", at 1500 kc. The ori inal call letters no longer have s nificance for listeners, since th

Highly specialized production lines that segregate the entire receiver circuit to its basic elements, plus simplified wiring, permit mass production with custom-built performance. Cell-unit assembly, according to functional requirements, limits repair stock and eases servicing. The 7-cell Harvey Receiver shown above measures only 10″ high, 8″ wide and 20″ deep—yet it provides four frequency bands, extreme sensitivity and a high degree of selectivity. Shown below are the general specifications of this advanced type Communication Receiver.

Frequency Bands: **1.48 mc to 2.475 mc; 2.45 mc to 4.2 mc; 4.15 mc to 7.1 mc; 7.0 mc to 12.55 mc.**

Sensitivity: **At a signal to noise ratio of 6 db, the sensitivity of this Harvey Receiver is 4 micro-volts—with a carrier sine wave modulated 30% at 400 cycles, impressed at the antenna terminal through standard IRE dummy to give 50 mw output.**

Image Rejection: **On the four bands enumerated above they are respectively 58, 58, 54 and 46 db's.**

I. F. Rejection: **50,000: 1 or better at all frequencies.**

****Performance data are approximate only.***

Inquiries invited for this Harvey Receiver–or other types of Electronic devices using Harvey "Unitized" cells.

For over a quarter century geared to flying production

Electronics Division

HARVEY

MACHINE CO., INC.

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Other Harvey Divisions aiding the United Nations

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SPECIAL MACHINERY DIVISION

Globar
REG. U. S. PAT. OFF.
CERAMIC RESISTORS

RESISTORS are, in the final analysis, energy dissipators and as such they should be rugged. Since the demands of electronic circuits are quantitatively exacting, a resistor should be electrically and mechanically stable. Ruggedness and stability in a resistor gives assurance that it will retain indefinitely its established resistance value under normal loading.

A good resistor should withstand, without suffering a permanent change in resistance, the maximum accidental over-voltage to which it might be subjected in service. Moreover a resistor should be relatively free from microphonic effects, inductance and capacitance and it should not be affected by humid atmospheres.

"Globar" Brand Ceramic Resistors meet these specifications. Right now deliveries must be scheduled according to priority ratings and date of order. Nevertheless we invite you to tell us about your needs; we pledge our best efforts to assist you.

The condensed table below gives you at a quick glance the physical and electrical characteristics of the more commonly used industrial type "Globar" Resistors.

TYPE		A	B	CX
LENGTH	Min.	¼"	¼"	¼"
	Max.	18"	18"	18"
DIAMETER	Min.	1/16"	1/16"	1/16"
	Max.	1"	1"	1"
RESISTANCE Per Inch of Length	Min.	25 ohms	5 ohms	1 ohm
	Max.	15 megohms	15 megohms	100 ohms
*OVERALL WATT RATING	Max.	54 watts	54 watts	150 watts
*NORMAL RATING W./Sq. In. of Radiating Surface		1 watt	1 watt	2½ watts
MAXIMUM VOLTAGE Per Inch of Length		400 v.	400 v.	**Note

*These ratings may be substantially increased by artificial cooling.

CHARACTERISTIC COEFFICIENTS:

TYPE A: Comparatively Straight Line Temperature and Voltage.

TYPE B: Negative Temperature and Voltage.

TYPE CX: Slightly Positive Temperature.

Other resistor types are available for specialized applications.

TERMINALS: Metalized ends for clip mounting or wire leads.

** Type CX resistors have a low specific resistance and cannot be subjected to voltage stresses permissible with Types A and B. Maximum allowable voltage is that required to yield maximum watt rating.

Globar Division
THE CARBORUNDUM COMPANY
REG. U. S. PAT. OFF.
NIAGARA FALLS, N.Y.

(Carborundum and Globar are registered trade-marks of and indicate manufacture by The Carborundum Company)

represent the initials of the late James S. Vance who owned the station prior to 1932.

The call letters of station WASH in Grand Rapids, Michigan, have been deleted by the FCC. WASH and WOOD had been sharing the same transmitter, but the FCC action of Feb. 16 granting full time to WOOD made the recent action a necessary formality. FCC policy favors the use of only one set of call letters where only one transmitter and one operation is involved, as was the case of WOOD-WASH.

FCC Releases Data on Salaries of Technical Radio Men

CHIEF ENGINEERS in radio stations averaged $65.55 per week during 1942, according to data released by the FCC. Technical employees in radio operating positions averaged $64.48 for 9 networks, and $46.94 for 791 individual stations. Technical employees doing research or development work averaged $84.89 in networks and $56.82 for stations, but only 105 men were listed in this category for both groups.

London News Letter

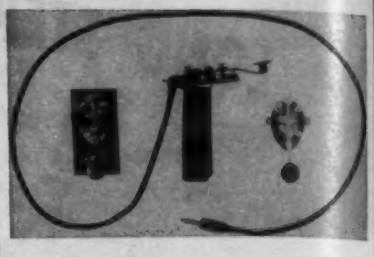
By John H. Jupe

London Correspondent for ELECTRONICS

Substitutes. The British Radio Manufacturers Association has nominated zinc as a fair substitute for aluminum condenser vanes, providing it is of suitable thickness and is kept well away from anything containing linseed oil. Brass (soft drawn) has been classed as reasonably satisfactory but steel is not recommended owning to the difficulty of maintaining tolerances and keeping the wear of existing tools (made for aluminum) down to a low degree.

Radio Relay Systems. Among many thousands of English people there seems to be a distinct liking for the relay radio principle, wherein they receive programs over wires from a central point. Certainly it limits the choice of programs but it is surprising, even in peace time, how most families stick to a few favorite stations. In June 1942, the latest date for which data is available, there were 398,985 wired radio subscribers and 278 relay exchanges. This represents an increase of 11,751 subscribers in three months.

TELEGRAPH and RADIO KEYS



Telegraph Keys to Signal Corps Specifications

Types now in production include

J-12, J-18, J-28, J-29, J-30

J-31, J-37, J-38, J-40, J-41-A

J-44, J-45, J-46, J-47, J-48

Quotations upon request

THE WINSLOW COMPANY
INCORPORATED
9 Liberty Street, Newark, N. J.

DANNEMAN PRECISION DIE-SETS

Precision Bored on Master-Plates

for accurate stamping of metal and mica film parts and components.

Of special interest to radio and radar, electronic and electrical, aviation and instrument manufacturers.

Swiss type die-sets for miniature parts.

Our experience in this field is your assurance of our ability to serve you well.

Literature on request.

Inquiries will receive prompt attention.

DANNEMAN DIE-SET COMPANY
Exclusive sales representatives:
ACME-DANNEMAN CO., Inc.
201 Lafayette St., New York
Telephone: CAnal 6-1759

Calibrations on meter face are easily read

MODEL 500A ELECTRONIC FREQUENCY METER

Model 500A is a direct reading Electronic Frequency Meter to read the frequencies in the range between 10cps and 50kc. At the higher frequencies you can measure the frequency difference between two radio frequency signals. In crystal grinding you can quickly measure the deviation from standard. As with all *-hp-* instruments, simplicity and speed of operation plus high accuracy are prime virtues. Excellent accuracy; plus or minus 2% of the full scale value: Good sensitivity; variation of the input voltage from 0.5 volts to 200 volts will affect the meter by not more than plus or minus 1%. Readings are independent of line voltage since a variation from 105 volts to 125 volts will affect the meter by not more than plus or minus 1%.

Get full particulars about this new *-hp-* instrument today. Data sheets will be sent you promptly and without obligation. Ask, also, for your copy of the new *-hp-* catalog which gives full information about other *-hp-* instruments and explains many standard tests and measurements.

HEWLETT-PACKARD CO.

BOX 1135 G STATION A, PALO ALTO, CALIFORNIA

● Manufacturers, like individuals, enjoy being in good company and usually associate themselves with other manufacturers whose dependable word and workmanship have given them a good name. Astatic's product engineering, precision in manufacture and performance in service, over many years, are now utilized in the manufacture of government approved Coaxial Cable Connectors, Multi-contact Plugs and Sockets and Dynamic Microphones for military radio equipment. Increased production now permits new radio manufacturer connections.

ASTATIC

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PINCOR Products
Keep 'Em Winning!
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CABLE: SIMONTRICE, NEW YORK

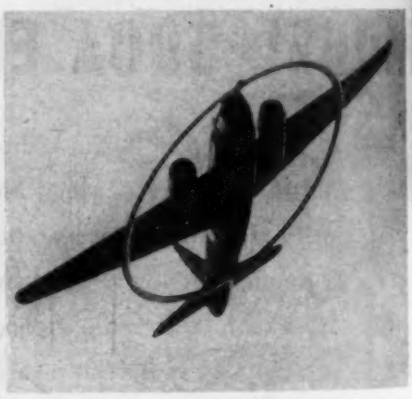
Exploding Magnetic Mines From the air. The British Government has lately disclosed one of the best kept secrets of the war—how electricity was used to destroy magnetic mines.

"Wellington" bombers were the machines used because of the great weight of the equipment. Each was fitted with a large diameter circular casing, extending from nose to tail and containing heavy gauge cable. Power was obtained from a d-c generator driven by a Ford V8 engine built into the plane. Detonation of the mines was secured by reason of the relay mechanism being operated. In order to make the magnetic field of the coil trip the relay mechanism in the mine, it was necessary for the plane to fly within 60 feet of the water. At such a short distance the blast of the mines was considerable, but it was found that the plane could just escape the tremendous column of water with nothing worse than a severe jolt. Not a single "Wellington" was lost by mine explosions.

This method of destroying Nazi mines has now been discontinued, after being used successfully for about two years, but nothing has yet been released regarding the newer and better system which replaces it.

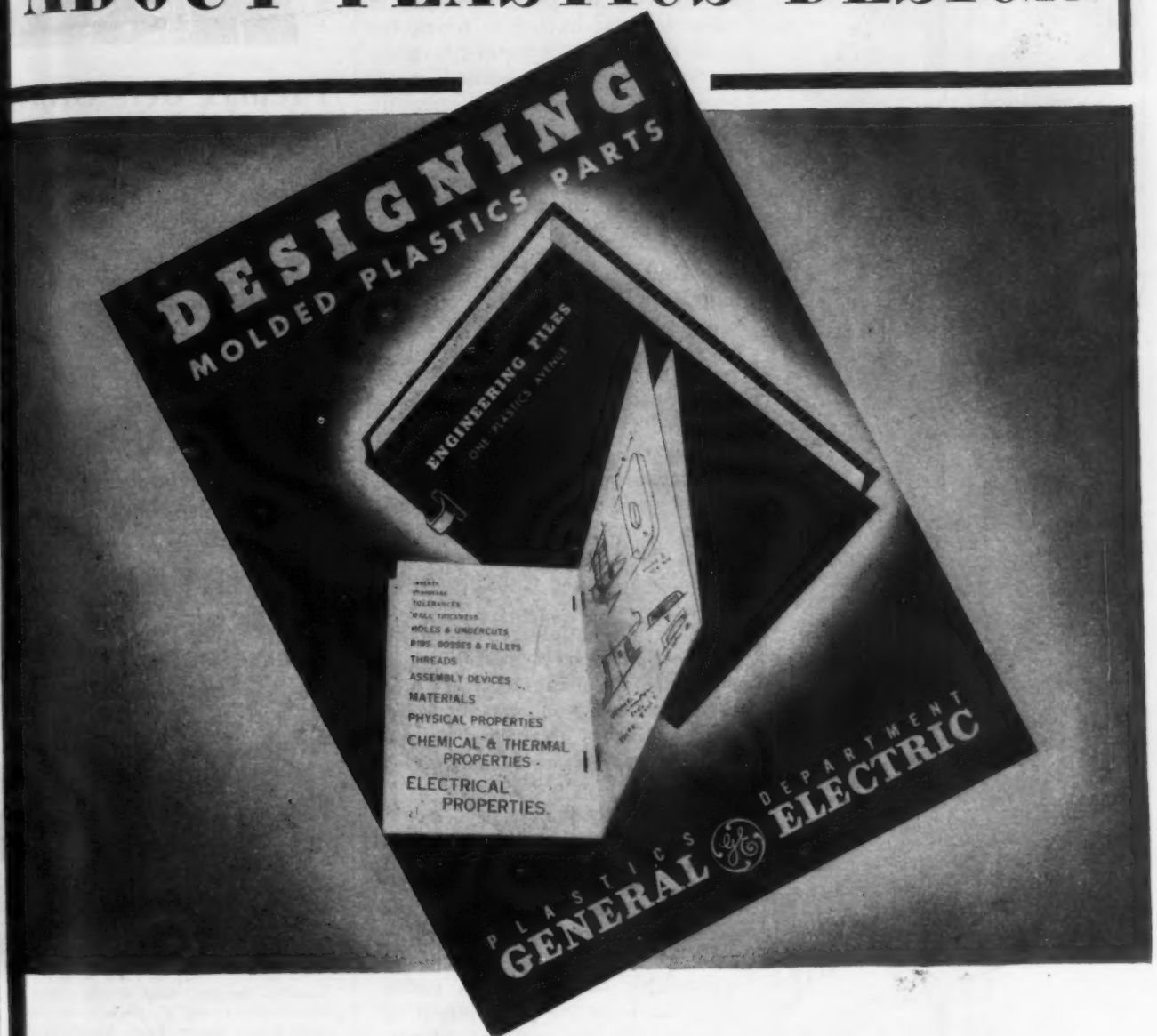
• • •

MINESWEEPER OF THE AIR



The minesweepers of the air are equipped with a hoop-shaped casing extending all around them and secured to their nose, wings and tail. The casing holds a magnetic coil and current is supplied by an auxiliary engine. This equipment was designed to set up a magnetic current which would set off the mine. The crews are severely jolted when the mines are exploded

FOR MEN WHO NEED TO KNOW
ABOUT PLASTICS DESIGN



Here—in a new 16-page bulletin—are the latest facts about designing molded plastics parts. This information has been prepared by General Electric Engineers who form the expert engineering staff of One Plastics Avenue, where stands the largest plastics molding plant in this country. Product engineers to whom we have shown this new bulletin declare that it is indispensable for men working with plastics. For copies write Section M-3, Plastics Department, General Electric Company, One Plastics Avenue, Pittsfield, Mass.

PLASTICS DEPARTMENT
GENERAL ELECTRIC

PD-21

"Demand the Best!"

J. S. STAEDTLER, INC.
53-55 WORTH STREET
NEW YORK, N.Y.

Death of Poulsen. From Denmark it was reported that the radio pioneer Dr. Valdemar Poulsen had died recently at the age of 63. His best known contributions to the radio art were the systems of arc telephony and continuous wave telegraphy.

Spare Cathode-ray Tube Screens. Patent No. 544,413 (British) was recently granted to J. L. Baird for a method of replacing screens in tubes without having to break the glass envelope. His method involves placing a pack of coated metal screens in the tube, and scanning from the front. When the first screen is "dead," it is moved into a well by an iron armature, operated externally by a solenoid, thereby exposing the next screen.

One-Farad Condenser. At a meeting of the British Institute of Radio Engineers, J. H. Couzens, an expert on electrolytic condensers, estimated that a one-farad electrolytic condenser could be mounted in the space of one cubic foot provided the maximum working voltage was limited to 3 volts. Looking at the question another way, this capacitance would be represented by the charge on a sphere the size of the sun, a fact first noted by the late Sir Oliver Lodge.

In the discussion subsequent to the meeting a very practical point concerning the manufacture of electrolytics emerged and was agreed to by a number of engineers. It was that the number of turns gives a more accurate gauge of capacitance than the length of foils used, which is just the opposite to what one would imagine.

Secret Ray to Stop Cars. Our old friend the "death ray" came to life again when a man at Manchester ascribed his bankruptcy as partly due to financing the development of a ray to stop motor cars and airplanes. Witnesses vouched for having seen a car stopped at a distance of two miles and coils destroyed at 70 feet. The financier himself claimed that the ray could destroy a car at 6 miles and that the current could go through a thick wall or even rubber. Unfortunately, however, the military authorities were not impressed and seized the apparatus. The gentleman estimated his loss, very modestly, at $400,000,000.

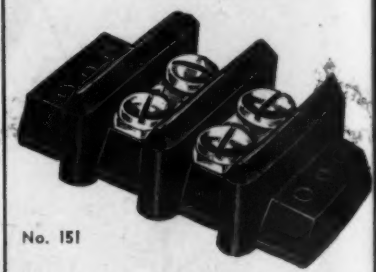
Premax Gets Orders
To the Forces

Premax Metal Antennas are maintaining communications between the armed forces on land and sea. Standard and special designs, complete with mountings, are shown in the Bulletin.

Premax Products

Division Chisholm-Ryder Co., Inc.
4302 Highland Ave., Niagara Falls, N.Y.

JONES
BARRIER STRIPS
SOLVE MOST TERMINAL PROBLEMS



No. 151

A compact, sturdy terminal strip with Bakelite Barriers that provide maximum metal to metal spacing and prevent direct shorts from frayed wires at terminals.

6 SIZES

cover every requirement. From ¾" wide and 13/32" high with 5-40 screws to 2½" wide and 1⅛" high with ¼"-28 screws.

Jones Barrier Strips will improve as well as simplify your electrical interconnecting problems. Write today for catalog and prices.

HOWARD B. JONES
2300 WABANSIA AVENUE
CHICAGO ILLINOIS

D-H
Alloy Craftsman
VOL. III DRIVER-HARRIS COMPANY NO. 2
FLIGHT TESTING
THE WORLD'S LARGEST PLANE . . .
Official Photograph, U. S. Army Air Forces
A new instrument, developed especially to compile test data on the Douglas B-19, world's largest military plane, is capable of automatically printing on paper, during the test flight, the temperatures of all 72 cylinders of the four motors, changing temperatures of the carburetor, exhaust and of the oil in the fuel lines, and the pressures on wing struts, bulkheads and tail surfaces! The instrument is a Brown flight recorder, and vital wires in the instrument are supplied by D-H.
*Trade Mark, Driver-Harris Company
Official Photo U. S. Navy
TEST PILOTS traveling at 7 miles a minute can hardly be expected to jot down dozens of necessary temperature and pressure readings when in a power dive or a steep climb. That's why the flight recorder, described below, was designed.
FIRST PICTURE of the "flight recorder" which makes possible new accuracy in flight testing America's fighting planes. Developed by Brown Instrument Co., a division of Minneapolis-Honeywell Regulator Company, this instrument is important aid to flight test officers like Lieut. William C. Clay, U.S.N., (left), shown inspecting the new instrument with E. B. Eveth, Brown vice president and general manager.
AN ELECTRONIC TRANSFORMER (right) was developed to take the place of the delicate galvanometers used in ordinary recording instruments. This instrument employs D-H Advance† wire in the thermocouple and D-H Manganin wire in the recorder itself.
† Trade Mark Reg. U. S. Pat. Off.

-H ALLOYS
dvance* and
anganin, in

NEW
RECORDER
FOR

HE D-H Alloy Craftsman is designed to keep you posted on the many Driver-Harris products . . . new es, improved practices and techniques are constantly ing developed. If you would like copies of this publiion send us your name and business address.

D-H Alloys are made in form of

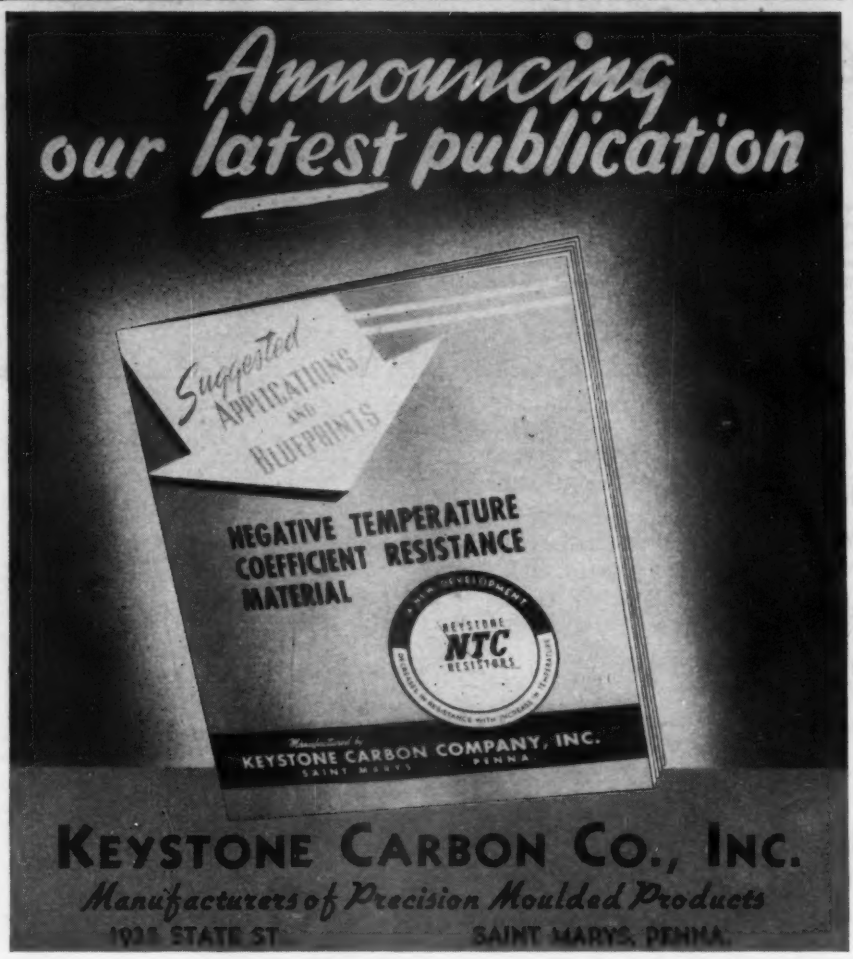
ROD — WIRE — STRIP — CASTINGS

DRIVER-HARRIS Company

HARRISON, NEW JERSEY

rade Mark Reg. U. S. Pat. Off.

GIVING ACCURACY
TO FIRING POWER!
Equally important to modern war machines as guns and armor, are the electronic signalling and control devices which guide them to their target, speed them on their way when disaster threatens, and bring them safely home when the elements run rampant.
DANIEL KONDAKJIAN tungsten and electronic tube components are serving in these vital capacities . . . helping to fulfill the superhuman tasks of today. Inquiries regarding present military needs, or post-war plans, are invited; write today.
THE ENGINEERING CO.
DANIEL KONDAKJIAN
27 Wright Street, Newark, New Jersey
TUNGSTEN LEADS DANIEL KONDAKJIAN BASES AND CAPS



Radio Business News

AN OPA WARNING states that any store or radio repair shop which refuses to sell tubes outright, requiring that the customer bring in his radio and pay a service charge, is violating the General Maximum Price Regulation unless that practice was customary with the store or shop in March, 1942.

WPB NOW PERMITS SWAPPING of goods by merchants when inventories are overly high in relation to local demand. The specific conditions under which controlled merchants may exchange goods on a barter basis are set forth in amendments to WPB Order L-219 (Consumer Goods Inventory Limitation). Communications regarding the order can be sent to the Wholesale and Retail Trade Division, 41 East 42nd St., New York City.

PRICE CEILINGS have been set on fixed capacitors of all types and sizes used for military radio equipment. The new ceilings are based on list prices effective on April 1, 1943, less any discounts, allowances or other deductions in effect on that date. Fixed capacitors have been exempt heretofore because of the necessity for increasing their production despite unstable conditions. Special provisions are included in the OPA order to cover future advances in costs of block mica and splitting and cutting sheet mica for mica condensers.

QUARTZ CRYSTAL PRODUCTION for radio transmitters, communications receivers, sound-detecting and locating apparatus for use against submarines and aircraft, range-finders, and test instruments, is being maintained despite material and manpower shortages. Improved production techniques and closer grading of both cut and uncut quartz, the use of smaller-size and lower-grade crystals in Signal Corps sets whenever permissible, and the training of women and over-age men are factors which have contributed to elimination of the quartz crystal bottleneck.

AIRCRAFT ACCESSORIES CORP. has opened its seventh plant in the Kansas City area. This one will be devoted entirely to the production of aircraft radio equipment, and will be under the supervision of Guy Melanger, general manager of radio production for the company.

In the sky or on the ground you can depend on

WALKER-TURNER FLEXIBLE SHAFTING

MANY of the mechanical weapons of this war are "quicker on the trigger," because of WALKER-TURNER FLEXIBLE SHAFTING. Its action is as positive in the stratosphere as on land.

As one of the largest manufacturers of flexible shaft machines for industry, we have had ample opportunity to observe the performance of the shafting we produce. It is designed to give unfailing service under the most difficult operating conditions. That is one reason why aircraft manufacturers, and others who use flexible shafting for important applications, specify "Walker-Turner".

If you have a problem in remote control or power transmission, get in touch with us. We have the answers to a lot of questions in our files.

WALKER-TURNER COMPANY, INC.
1453 Berckman Street, Plainfield, N. J.

walker-turner
COMPANY, INC.
PLAINFIELD, N.J.
U.S.A.

FLEXIBLE SHAFTING

FOR REMOTE CONTROL AND POWER TRANSMISSION

Indicates by reflected light, visible light, "black light" and by fluorescent-radio-active luminescence. *Operates* by solenoid. When activated, "butterfly" opens instantly showing signal. *No blur,* no dimming. *Non-shatterable* protection. Plastic cap withstands severest tests. *No burn-outs* as with lamps; no delicate parts to break from shock or shell explosion; no spare lamps required. *Uses about* ½ current of filament lamps.

Wire or write for Signalette Bulletin. Ask about samples for test

LITTELFUSE
INCORPORATED

4755 Ravenswood Avenue
Chicago, Illinois

•

225 Ong Street
El Monte, (Los Angeles suburb)
California

THE BAN ON VISITORS to broadcast stations and to plants engaged in manufacturing communications equipment has been relaxed to the extent that United States and Canadian citizens may now visit these plants if on legitimate business.

STROMBERG-CARLSON COMPANY is the shortened corporate name selected by stockholders of the Stromberg-Carlson Telephone Mfg. Co. The name was shortened to make it apply more appropriately to present radio broadcasting and manufacturing activities.

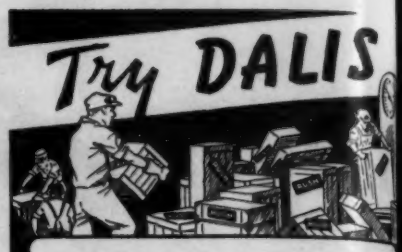
AEROVOX CORP. has opened a second plant in Taunton, Mass., with some 60,000 sq ft of production space which will be devoted exclusively to the manufacture of mica capacitors. This will virtually double the Aerovox mica capacitor output, now running well into hundreds of thousands of units weekly.

KEN-RAD will soon begin production in two new plants. One is located in Bowling Green, Ky., will cover 80,000 sq ft and employ 2300 workers, and will produce radio and secret ordnance equipment for the armed forces. The other is in Tell City, Ind., employing 1500 workers in manufacturing materials for the Army Signal Corps.

SYLVANIA ELECTRIC PRODUCTS reports a new sales high for 1942, resulting in a profit of $1,057,760, essentially the same as for 1941 despite a 91-percent increase in taxes. Taxes for 1942 represented 70.7 percent of income, whereas taxes for 1941 were 55.5 percent of income.

TUBES FOR CIVILIANS will carry brand names of manufacturers instead of the general designation "Victory Line." Most manufacturers have indicated that they will mark tubes also with the initials "M.R.", for "Maintenance and Repair."

UNITED ELECTRONICS CO. of Newark is combatting absenteeism and employee turnover with a trust fund into which goes a proportion of current war-work profits, for distribution after the war to those who stay with the company until the end of the war or until called into military service. Government tax officials have approved the plan.



•**Dalis is supplying radio and electronic materials to many branches of the armed forces, war plants, sub-contractors, laboratories, training schools, etc.**

Ample stocks on hand provide prompt shipment on many items. And if required items are not in stock, Dalis go-gets 'em for you in shortest possible time.

•**Try Dalis — write, wire or 'phone . . .**

H. L. DALIS, Inc.

Distributors of
RADIO & ELECTRONIC SUPPLIES
17 Union Square • New York, N. Y.

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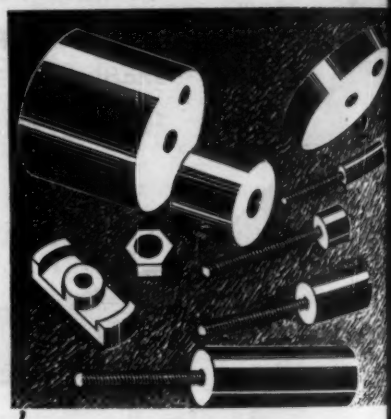
DALIS SERVICE

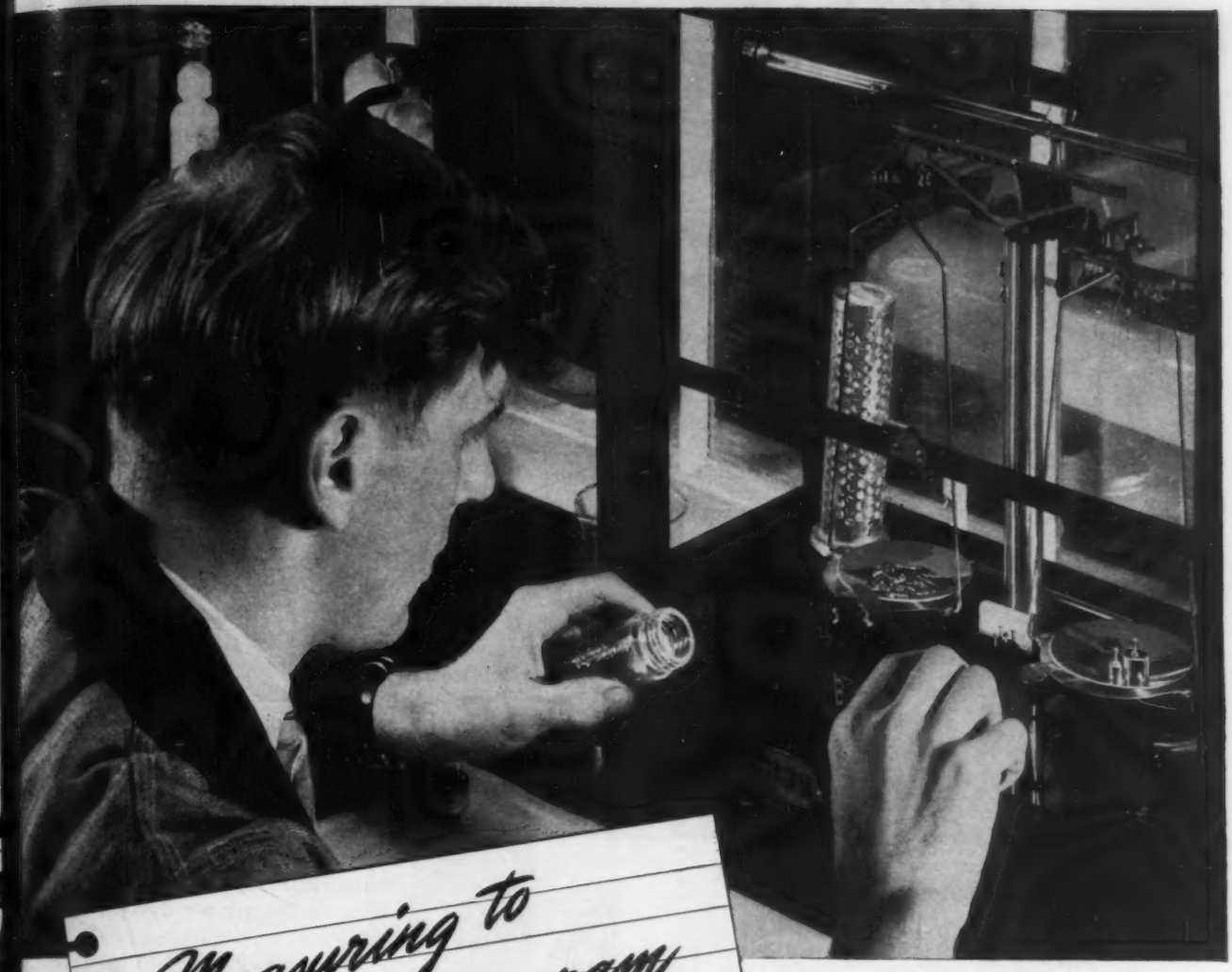


PyroFerric Cores of powdered Iron or Copper have no limitations in size, shape or insert. PyroFerric are specification cores to fit any circuit.

PyroFerric Cores are being made in quantity for the electronic industry's war effort.

If you require Cores to speed the war effort send us your specifications and we will rush samples to you.

PYROFERRIC CO
175 Varick Street, New York, N.Y.



Measuring to 1/10,000 gram

- TO MAKE A BETTER SPRING!

★ A prime requisite of precision spring making is the technician's control of the exact composition of the metal used. He must know, for instance, *to one hundredth of one percent,* the amount of carbon present in spring wire, since a very slight excess in carbon content will increase tensile strength at the expense of ductility.

In this analysis for carbon, pure oxygen is passed over a sample gram of white-hot steel chips. The oxygen combines with the carbon present in the steel to form carbon dioxide. This gas is then collected by absorption and weighed—an almost infinitesimal measurement indicating the amount of carbon present.

Such painstaking thoroughness, from the selection of raw stocks to the inspection of the finished product, explains the high performance rating of Muehlhausen Springs.

MUEHLHAUSEN SPRING CORPORATION
Division of Standard Steel Spring Company
760 Michigan Avenue, Logansport, Indiana

SEND FOR TWO NEW FOLDERS—FREE

New Die Spring Bulletin illustrates, describes 206 sizes and types of die springs.

New Armament Bulletin shows importance of springs for many types of war equipment.

MUEHLHAUSEN
MS
SPRINGS
EVERY TYPE AND SIZE

WE TOO, FIGHT
...FOR PEACE!

Lafayette is doing its part to win the war...*and* the peace that must surely follow. We play the important part of speeding the war effort by supplying emergency requirements of radio, sound and electronic parts to all branches of the armed forces as well as to manufacturers and sub-contractors. Lafayette is in there fighting to save you time by supplying all of your needs in one order—*quickly!*

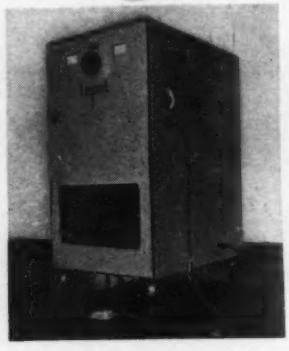
Now it is no longer necessary to comb the field to find the various parts you need. Due to Lafayette's extensive buying facilities and large, diversified stocks, one order (no matter how large or how small) will bring quick deliveries on *all* of your requirements.

Free catalog—Radio, Sound and Electronic Parts—Dept. 5G3

LAFAYETTE RADIO CORP.
901 W. JACKSON BLVD., CHICAGO, ILL.
265 PEACHTREE ST., ATLANTA, GEORGIA

"Quick Deliveries on Radio, Sound and Electronic Parts"

★ SOLDERING
★ BRAZING
★ BOMBARDING
★ HARDENING
★ ANNEALING
★ MELTING



A COMPACT **LEPEL**
HIGH FREQUENCY
INDUCTION HEATING UNIT

. . . performs all these operations quicker, simpler, more efficiently and at a fraction of the cost. Complete engineering data on your work is freely offered. Send samples, or write for catalog E today.

Lepel
HIGH FREQUENCY LABRATORIES, INC.
39 West 60th Street, New York, N. Y.
PIONEERS IN INDUCTION HEATING

FRED E. GARNER CO. announces the opening of Plant No. 2 in Chicago, to be devoted to manufacturing frequency meters, test equipment, radiotelephones, radio direction finders, silent and sound picture projectors and other electronic devices.

CLAROSTAT has begun production in its second plant in Brooklyn. Plant No. 2, which will be devoted entirely to assemblies, provides greater production floor space than the original plant.

Latest FM Developments

FOUR PHILADELPHIA FM STATIONS have received FCC permission to try out for 90 days a cooperative plan of broadcast rotation which will keep one station of the four on the air from 3 to 11 p.m. each day. Each station will have one regular day per week, and the remaining days will be rotated among the stations.

Wartime shortages of manpower, critical materials, electric power, record libraries and transcriptions were advanced as reasons for granting the waiver from pre-war regulations requiring a minimum of six hours on the air per day per station. The stations involved (W49PH, W53PH, W69PH and W73PH) will pool all spare parts and equipment, and will set up a committee to coordinate and supervise the programs.

A MORE GENERAL FCC ACTION suspended until further order the ruling requiring FM stations to submit continuous field intensity records along several radials as a check on the actual service area. This type of survey requires the considerable time and services of skilled personnel and the use of measuring equipment installed in an auto or truck.

FM STATIONS can now keep their licenses with a minimum daily service, except Sunday, of 6 hours during any portion of the broadcast day. The required 2 hours of programs unduplicated by other FM or AM stations can be during any part of the broadcast schedule. Heretofore, at least 3 hours had to be between 6 a.m. and 6 p.m. and 3 hours more between 6 p.m. and midnight. At least one hour of unduplicated programs was required in each of these periods.

—ALL we can
—the BEST we can
—as FAST as we can

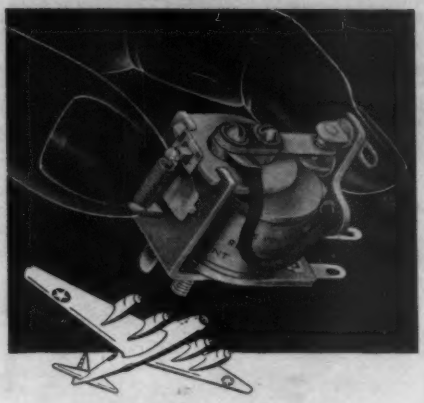
This is America's simple formula for victory. Nothing less is good enough in the urgency of battle. And nothing less, on the home front, is worthy of our valiant fighting men. To them, we at Simpson make this report. We are manufacturing many times more Simpson Instruments than ever before . . . making them the best that skill and experience, and resolution, can produce . . . and turning them out at a pace we would have thought impossible just a short while ago.

SIMPSON ELECTRIC COMPANY
5200 - 5218 Kinzie Street, Chicago, Illinois

Simpson

INSTRUMENTS THAT STAY ACCURATE

Buy War Bonds and Stamps for Victory



THE ADVANCE *MICRO* RELAY IS DOING A GREAT JOB ★

TIME-TESTED in hundreds of applications from aircraft to signal corps communications, the Advance Micro Relay has that vital qualification—RELIABILITY. One of the first small relays on the market, this dependable unit is doing a great job on all fronts. Maybe it is exactly what YOU need.

ADVANCED MICRO RELAY HIGHLIGHTS

★ Available from Single Pole, Single Throw to Four Pole, Double Throw. ★ Capacity: 2 to 220 Volts A.C., and 1 to 60 Volts D.C. ★ Stationary Contacts mounted on heavy copper terminals minimize maladjustment. ★ All Contacts insulated, positioned above Ground. ★ Lug Terminals well spaced for easy soldering of connections. ★ Good clearance between Contacts permits control of higher voltages. ★ Weight: 3 oz.; Dimensions: 1¾" x 1⅛" x 1". ★ All metal parts A & N plated. ★ All Bakelite parts are wax-impregnated to prevent moisture absorption.

OTHER ADVANCE RELAYS

are made for general circuit control applications. They include: Ceramic Insulated Relays (Double Pole, Double Throw, with extra Single Pole, Single Throw if desired) for antenna changeover or other R. F. Circuits.

Each Advance Relay receives individual adjustment and inspection. Close attention is given orders. Write for details today.

Advance Relays

ADVANCE ELECTRIC COMPANY

1260-1262 West Second Street, Los Angeles, California

Personnel

Brigadier General Frank E. Stoner has been appointed to the post of Chief of the Signal Operating Services, which places him on a parity with Major General Roger B. Colton, Chief of the Signal Operating Services. Both are directly under the Chief Signal Officer. General Stoner started his army career as a private in 1914. As director of the Army Communications Division during the past year, he guided the construction of the telephone carrier system lines along the Alcan Highway from Edmonton to Dawson Creek, the longest carrier system in the world.

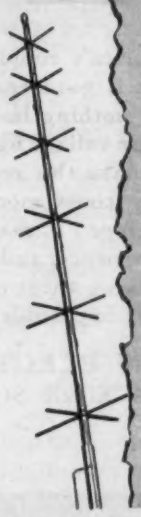
Colonel Ira H. Treest takes over the directorship of the Army Communications Division to succeed General Stoner. Col. Treest had 11 years of practical communication experience with the Pacific Telephone and Telegraph Co. prior to joining the 8th Field Signal Battalion in 1917, and has remained in the Army in varied Signal Corps assignments since that time.

Rear Admiral Stanford C. Hooper retired from active duty March 15, 1943, after a varied career of over 40 years in the Navy and particularly in Navy radio work. He plans

to devote the immediate future to assisting the electronics industry in every way possible as a consultant, in the present war effort as well as in preparing for post-war conditions.

Lionel E. Moore, X-ray application engineer with Westinghouse for the past 10 years, has been named by Westinghouse as X-ray Division manager for its Portland area.

TOMORROW
will be the day of
FM and LINGO



•Our past developments and present day experience with FM Antennas will provide greater efficiency in design and performance to meet the exacting standards of this important field.

We're "all out" for Victory, but our engineers are ready to work with you on post-war plans.

JOHN E. LINGO & SON, Inc.
CAMDEN, NEW JERSEY

PLUGS JACKS

U. S. ARMY
SIGNAL CORPS
U. S. NAVY
APPROVED

NAF-1136-1
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Prompt Deliveries

UNIVERSAL MICROPHONE CO., LTD.
424 WARREN LANE
INGLEWOOD, CALIFORNIA

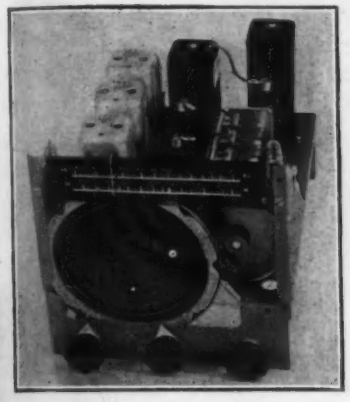
RADIO
RECEIVER AND TRANSMITTER CHASSIS
FOR *Your* APPLICATION

SMALL: — Various types of Receivers and Transmitters require a space only 7″ wide, 10½″ deep and 7½″ high.

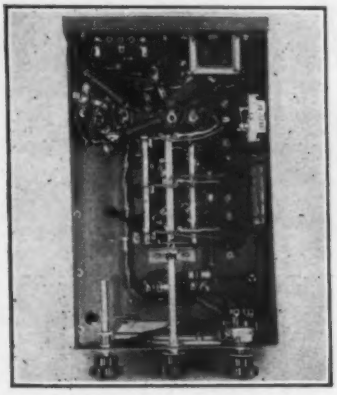
PERFORMANCE: — ***Receivers*** with 1 microvolt sensitivity, high selectivity with a band width of only 16 KC at 30 DB down. Tunable, multi-channel crystal controlled or combination models available.

Transmitters with up to four crystal controlled channels, built-in antenna matching network, 20-25 Watts power output with 100% modulation capability on phone. 10 watt model with power supply on same small chassis also available.

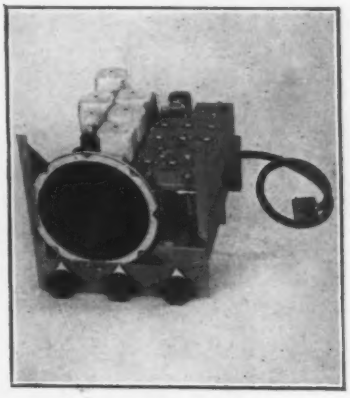
VERSATILE: — Operation on 6, 12, 32, 110 volts DC; 117 volts AC or various DC-AC combinations. Dynamotor or Vibrator power supplies available for operation of transmitters and receivers.



Series 6 tunable receiver. 2 band model illustrated, range 550-4000 K.C.



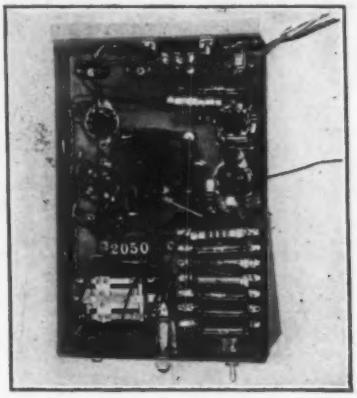
Under chassis view Series 6 tunable receiver.



Series 6, five channel fixed tuned receiver. Model illustrated not crystal controlled.

★ ★ ★ ★ ★

Series 20, 4 channel 1600-6000 KC, 20 watt transmitter.

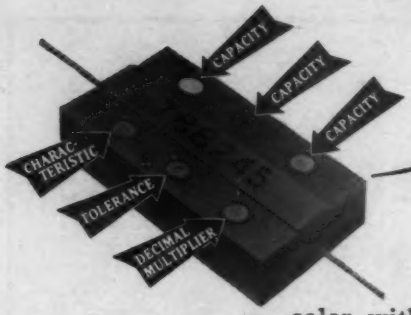


Under chassis view Series 20 transmitter.

★ ★ ★ ★ ★

KAAR ENGINEERING CO.
PALO ALTO, CALIFORNIA

Manufacturers of High Grade Mobile and Central Station Radiotelephone Equipment



300 *different* **COLOR DOTS A MINUTE**

Completely color-coding this condenser. Every dot a different color with a special meaning. The part number is done at the same operation.

MARKEM

VARIABLE DESIGNATION MARKING MACHINES

BOXES, LABELS, TAGS, ENVELOPES, TICKETS, LABELS FROM CONTINUOUS ROLLS, COLLARS, SOCKS, STOCKINGS, SHIRTS, SHOE LININGS, TEXTILES, LEATHERS, SYNTHETICS, GLASS, METAL, WOOD, PLASTICS, PRINTED SURFACES, RUBBER SHEETS, ABRASIVES

SHAPE AND SUBSTANCE PRESENT NO PROBLEMS. There's a Markem machine to identify or decorate every part or product known to industry. And out of the Markem laboratories come special process inks, rotatable type wheels, special type bars or master printing plates so that Markem is the only source of supply you need for marking machines, devices and supplementary materials.

A MARKEM Dial Feed Automatic Machine with flexibility to permit quick change-over for all three sizes of condensers and for colors of dots *(17 standard color changes)*, was developed to replace hand work.

Every manufacturer of condensers in volume is using or planning to use this machine, and our purpose in advertising it is not primarily to sell machines for this specific work but rather to demonstrate how Markem equipment solves marking problems—brings marking into line with speed production on any material, plastic, wood, metal, cloth or paper.

MARKEM machines give clean, permanent identification and designation marking "Markem" means a service — machines, methods and ink, plus specialized engineering skill. *Ask for Catalog L5.*

Put your marking problem up to MARKEM

MARKEM MACHINE COMPANY
KEENE N H
Builders of Industrial Ink Marking Equipment

You Made 'em - Now MARKEM!

GONE ARE THE DOODABS! TODAY THE *Accent* IS ON

RUGGED CONSTRUCTION

of

- CABINETS
- CHASSIS
- PANELS
- RACKS

for ELECTRONIC APPARATUS

Send specifications; or write for our Catalog No. 41A.

PAR-METAL PRODUCTS CORPORATION

32-62—49th STREET . . . LONG ISLAND CITY, N. Y.

Export Dept. 100 Varick St., N. Y. C.

Edward C. Cahill has been named president of a newly formed RCA subsidiary known as RCA Service Co., Inc., which will carry on all technical service activities of the RCA Victor Division. He was formerly manager of RCA Victor's sound equipment activities. W. L. Jones, former manager of RCA Victor's Service and Installation Division, becomes vice-president and general manager of the new company. RCA Service Company, Inc., will devote a major part of its activities to the installation and servicing of vital radio and sound equipment for the armed forces, throughout the world.

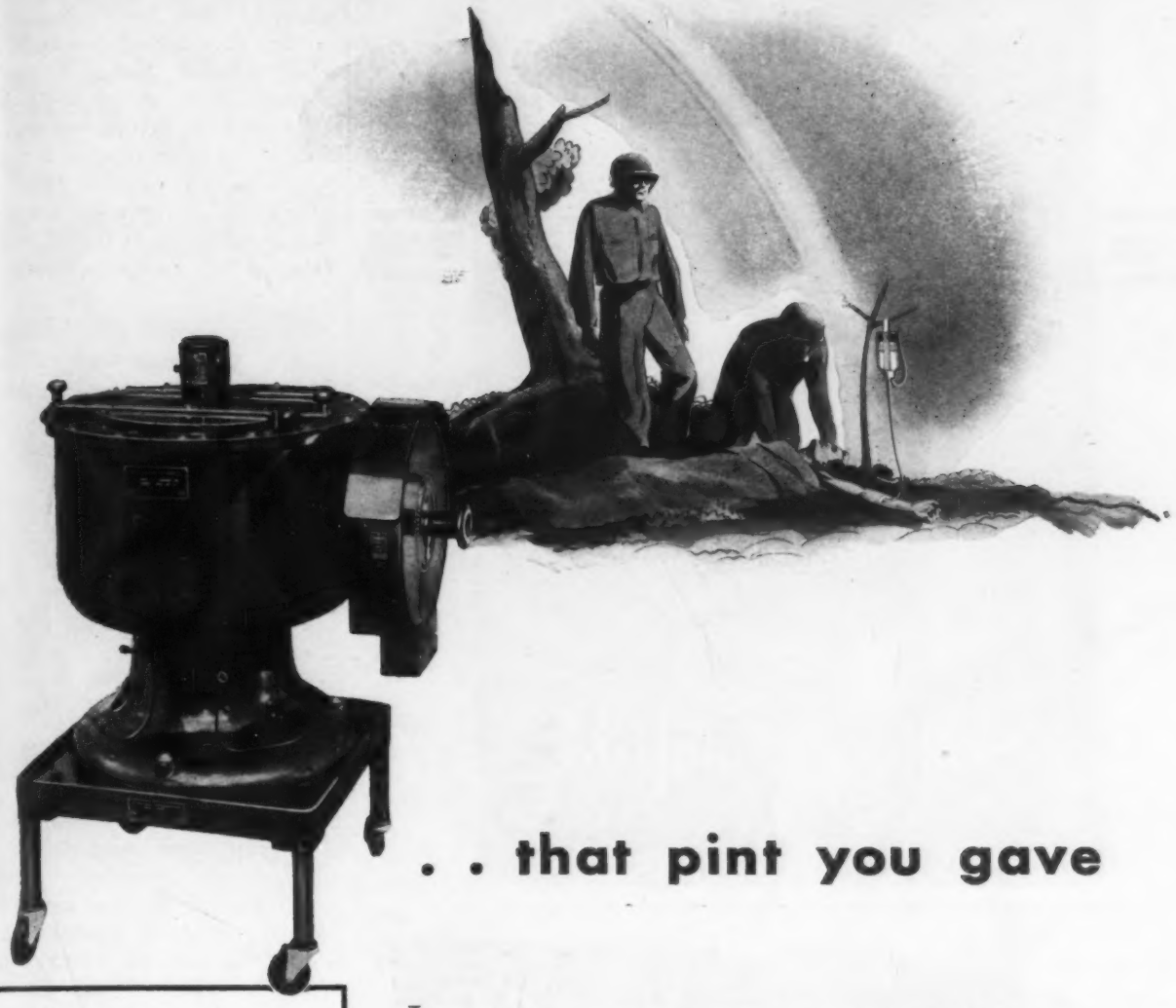
Henry D. Moreland, who joined the Portland, Oregon, X-ray unit of Westinghouse in 1933 as a service man, has recently been appointed manager of the entire X-ray products, agency and specialties department of Westinghouse, with headquarters in East Pittsburgh.

Gerald E. Spates and Ash Wood have been elected Vice-Presidents of Littelfuse, Inc., manufacturer of aircraft and instrument fuses and accessories.

D. H. O'Brien, after 26 years with Graybar Electric Co., Inc., which brought him up to the position of Vice-President, has retired to devote himself entirely to work in the Signal Corps. He will head the new Field Service Division, and in civilian capacity will supervise the coordination of distribution of signaling equipment and spare parts.

A. E. Snyder has become Manager of the Industrial Electronics

Division of North American Philips Co., now engaged in electronic research and development work for the government.



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Rheostats of the type shown on the International Blood Plasma Centrifuge are available in a wide range of sizes for multi- and single-mounting, for manual and motor driven operation. Ward Leonard also manufactures laboratory rheostats with and without micro drive and ring type rheostats. Send for bulletins describing Ward Leonard Rheostats of interest to you.

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It may be that many months will pass before the blood you so generously gave will save a life . . . the place may be thousands of miles away.

The preparation of plasma from donor's blood is a meticulous process in which a special type centrifuge plays an important part. Centrifugal force developed at enormous speed, with smooth acceleration, packs down the red cells and increases the yield of blood plasma. This calls for sturdy equipment, built for continuous duty; for when blood is coming in, the centrifuges are working day and night.

The Ward Leonard pressed steel rheostat was selected as the motor controller because of its absolute dependability and its large number of accurate steps. An electric interlock designed by Ward Leonard assures a slow start irrespective of when the switch is closed. The centrifuge will not operate until the rheostat is in minimum speed position.

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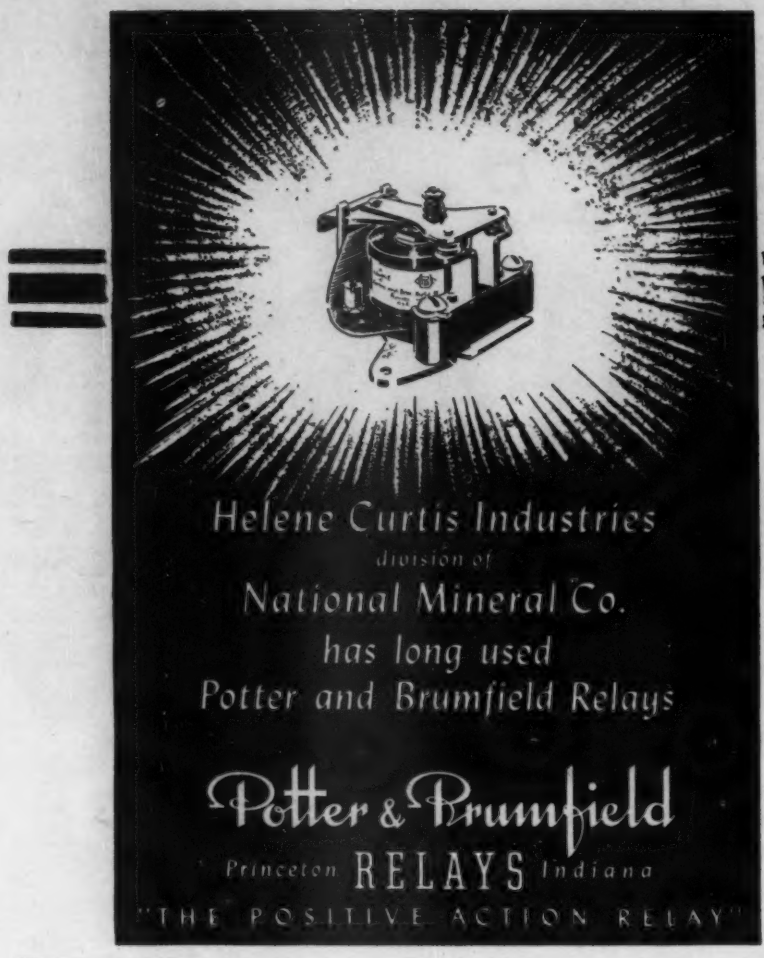

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COMMUNICATIONS are the nerve-center of modern warfare. Where the battle is hottest today, there our radio broadcasting and receiving equipment is leading the way to Victory. And there, on America's far flung battle fronts, you'll find BUD Products — and in them just one of the reasons our Nerves of War are so steady today.

BUD RADIO, Inc.
CLEVELAND, OHIO

Dr. Charles M. Slack, research physicist, has been appointed assistant director of research at the Westinghouse Lamp Division in Bloomfield, N. J. In 1940, he and his associates introduced an experimental ultrahigh-speed x-ray tube which made it possible for the first time to secure an x-ray photograph of a human foot as it kicked a football. Army ballistic experts are

now using this x-ray equipment to photograph high-speed bullets passing through the steel barrels of guns. Dr. Slack also developed a Lenard ray tube having a glass window as thin as a soap bubble, through which pass powerful streams of electrons suitable for treating local skin infections, for turning certain oils into solids and for other experimental purposes.

Bob Henry, distributor of short-wave communications receivers, has been appointed to the Radio Procurement Division of the Bureau of Ships, U. S. Navy.

Dr. Irving Langmuir, associate director of the General Electric Research Laboratory, has been elected to honorary membership in the Institute of Metals in London. Dr. Langmuir's recent investigations on surface films have been applied to the flotation process used in separating metals from ores, and his work on the emission of electrons from heated metals has led to a better understanding of the nature of metals. The only other living honorary members of this international association are Prof. C. A. F. Benedicks of Stockholm and Dr. A. M. Portevin of Paris.

Gerald C. Gross, FCC acting assistant chief engineer, entered the Navy as a Lieutenant Commander, and has been assigned to the Radio Division in the Bureau of Ships. He is serving under Lt. Comdr. W. G. H. Finch, who is president of Finch Telecommunications, Inc., and has been on active duty since the beginning of World War II. Lt. Comdr. Gross contributed to the development of the present interlocking aural aviation beacon while on the staff of the Bureau of Standards, participated in formation of the engineering division of the old Federal Radio Commission in 1928, and served as Chief of International Division of FCC.

Joseph R. Redman, Director of Naval Communications, was promoted to the rank of Rear Admiral on April 6, after serving over six months in command of a cruiser in a combat zone. Admiral Redman is one of the youngest officers ever to direct Naval Communications.

Commander David R. Hull of Naval Research Laboratories is the new Chief of the Design Branch in the Radio Division, Bureau of Ships.

Renald P. Evans has recently been elected a partner and made General Manager of the Turner Co. of Cedar Rapids, manufacturers of microphones and electronic

equipment. His time will be divided between maintaining a sizable volume of war business and directing the plans for increasing the use of Turner equipment during the post-war period.

5KVA VARIAC

You may need this largest Variac for controlling voltage on motors, heaters, flood lights, transmitter tube filaments, rectifier systems, or process equipment. Wherever line voltage varies and operating voltage must be correct, you will find this manually operated, continuously adjustable autotransformer gives smooth control and good voltage regulation at high efficiency. Designed for circuits of moderately high power, the Type 50 Variac is rugged, dependable and convenient.

Prompt delivery can be made on priority rating of A A 3 or better.

TYPE 50 VARIAC SPECIFICATIONS

Input Voltage: Type 50-A, 115 volts, and Type 50-B, 230 volts.

Output Voltage: Voltages up to 117% of line voltage can be obtained. Connection can also be made for maximum output voltage equal to line voltage.

Load Rating: 5 kva for the 115-volt model; 7 kva for the 230-volt model. Ratings are for 50° C. rise.

Rated Current: 40 amperes for the 115-volt model; 20 amperes for the 230-volt model.

Maximum Current: 45 amperes for the 115-volt model; 31 amperes for the 230-volt model.

Regulation: At output voltages ranging from 17% below to 17% above line voltage the full load regulation is less than 4%.

Losses: No load losses are about 1% of full-load power; full-load losses are about 2%; losses at half maximum output voltage are about 4%.

Driving Torque: From 1 to 2 pound feet.

Net Weight: 85 pounds.

Dimensions: Approximately 12 inches high x 16 inches diameter overall.

Price: $100.00 F. O. B. Cambridge.

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Forestville, Connecticut

John Kelly Johnson resigned his position as senior engineer in Hazeltine Electronics Corp. to become special representative assigned to the Office of Procurement and Materiel of the Office of the Under-Secretary of the Navy.

Martin Codel, publisher of *Broadcasting,* is on indefinite leave of absence while serving in Africa as director of public information for the Red Cross in that military theatre.

Warren Bookwalter, principal engineer mechanic at the Signal Corps Laboratories in Fort Monmouth, died March 17 after 24 years of almost continuous employment in the laboratory.

Roy M. Smith has been appointed Chief Engineer of Roller-Smith Co., Bethlehem, Pa., manufacturers of electrical laboratory equipment.

Alva J. Carter, pioneer radio manufacturer and inventor of many radio and television products, died recently in Chicago at the age of 60. "Nick" was widely known in radio manufacturing circles, and was president of the Carter Motor Co.

Dr. T. D. Yensen, scientist of the Westinghouse Research Labs, saved his "A" coupons by skiing two and a half miles to work on snowy mornings. He is shown displaying his pass to a Westinghouse policeman at the laboratories entrance. Dr. Yensen is a leader in the Western Pennsylvania Ski Patrol which has charge of policing the mountains and wooded areas in wartime

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The number of uses to which Hodgman Saran Tubing can be put are limited only by your own requirements. Its electrical properties make it suitable for most insulation work. Its physical properties provide an ease of handling hitherto unknown. Saran is non-corrosive and, being impermeable to water, provides absolute waterproof protection. Available in O.D. sizes from 1/8" to 3/4" with walls of varying thicknesses.

Send for Technical Data Sheet No. P-4 for further information about this remarkable plastic tubing . . . Specify O.D. size of free sample you would like us to send you.

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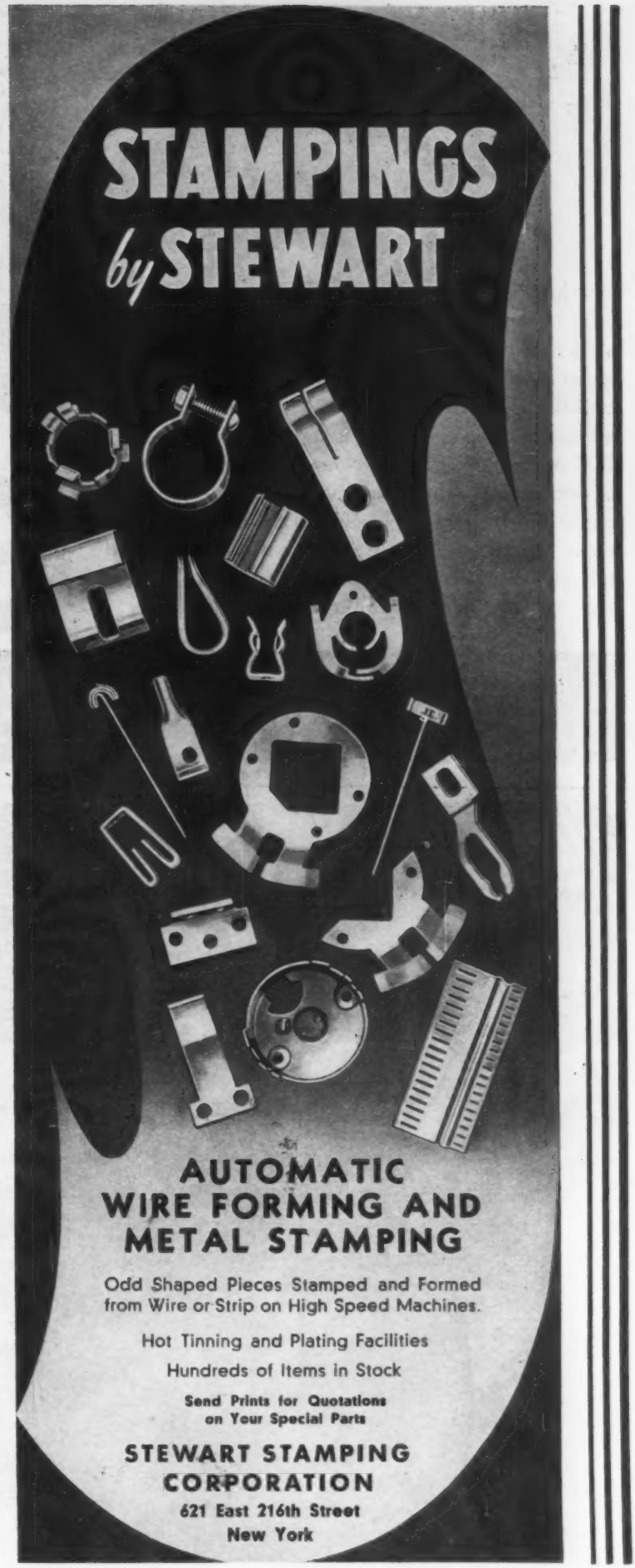
Cambridge, Mass.

U. S. Maritime Commission "M" award was presented to Radiomarine Corp., New York City.

Wave Meter Calibrator

Philco has developed an automatic electronic calibrator which calibrates Army Signal Corps wave meters in 15 minutes instead of the former 2½ hours.



The number of men in a plane or tank crew is kept to a minimum. Each man has his job to do. This *minimum of manpower* requires a *maximum of motor power* . . . motor-controlled apparatus that operates at the touch of a finger and functions with utmost accuracy. *Eicor D. C. Motors* have been developed to a high degree of efficiency. They are remarkably light in weight for power output—thoroughly reliable—and are used to actuate instruments, turrets, fire control and other critical equipment. This advanced engineering is your assurance of better motors at lower cost *tomorrow!*

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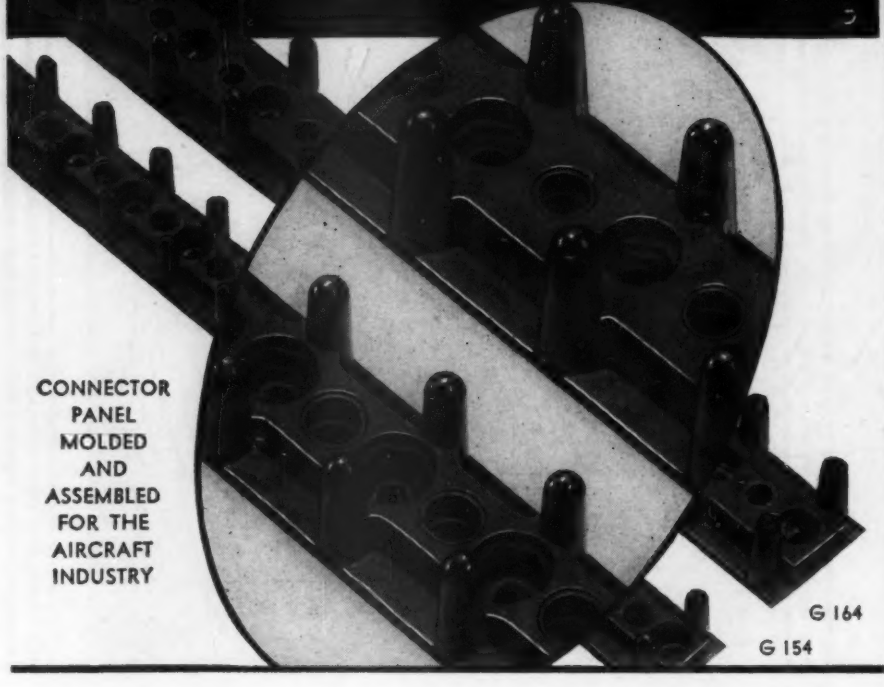


CONNECTOR PANEL MOLDED AND ASSEMBLED FOR THE AIRCRAFT INDUSTRY

G 164
G 154

U-H-F Broadcasting

(*Continued from page* 97)

audio tube is 10 volts, so the diod will rectify no signal of less valu than 10 volts.

The system is so designed that fractional microvolt signal havin 7000 cycle modulation will generat 20 volts peak across the input to th diode. The diode, being biased 1 volts negative, ignores voltages lowe than that, and gives 10 volts out a rectified d.c. from the 20 volts input A signal of any strength modulate at 6500 cycles or 7500 cycles, how ever, is sharply limited by the firs audio tube and generates only 9 volt or so, which is insufficient to over come the bias on the diode and n output voltage at all results—an in finite ratio of selectivity.

The problem of picking out the de sired carrier from such a closel spaced series as set up in our prob lem can thus be solved by "second ary tuning"—i.e., tuning the re ceiver as close as practicable to th desired carrier, then tuning the cir cuits of the filter to the tone identi fication of the desired carrier.

Considerable simplification of th system can be had in several way to meet commercial requirements The half-cycle oscillator can be re placed by using the noise output o the receiver which exists when n carrier is tuned in. This noise is im pressed on the control tube grid an swings it rapidly and at random, bu within a fraction of a second it wi pass through the signal and b locked.

For FM reception the system i ideal since the director is alread available.

The system has worked out well i mobile and aircraft application where the operating conditions ar more severe than the home broadcas receiver. It always has the advan tage that the signal, no matter ho weak, is always contacted in a frac tion of a second, and tuned in wit an accuracy far beyond the abilit of manual tuning. It also is immun to drift in the receiver.

Editor's Note. Four patents have been issue to Mr. White which relate to the propos system outlined in this article. They a Nos. 2,265,016 on an oscillation generato 2,283,523 on a scanning receiver, 2,287,2 on a scanning receiver, and 2,300,081 on radio receiver.

D-C Motor Control

(Continued from page 103)

armature current and its consequent heating factor can be reduced by connecting a d-c reactor in series with the armature. In this case the armature current wave forms will be more nearly like those of the highly inductive field and the voltage across the armature terminals will be of a shape corresponding to RI drop plus counter e.m.f. Polyphase equipment inherently will have much better current wave form so that the small amount of armature inductance will smooth out the ripples in the current sufficiently to make the additional heating effect negligible.

In contrast to the armature circuit, the field circuit is usually so highly inductive that the current flowing through the field winding has very little current ripple over the normal range of operation even though the field voltage may have considerable voltage ripple. Under these conditions, each field thyratron conducts current for a full half cycle, that is, until the next thyratron tube is fired. For a field winding having a high ratio of inductance to resistance, the field current is reduced to a very low value when the grid voltage and current are only 90 degrees out of phase. However almost 180 deg. of shift is required to reduce the current to zero.

If the tube firing is delayed to predetermined points within the successive positive half-cycle of the alternating voltage wave, the tube current does not begin to flow until a late point in each voltage wave. This condition in which the current lags the voltage suggests that the power factor must be changing as a function of grid phase control. The grid-controlled gaseous discharge rectifier achieves grid control of output voltage at the expense of lagging power factor on the a-c input side. This power factor improves as the grid phase is advanced toward the full output voltage, and at reduced output voltage the load is also reduced so that the effect of a lower power factor load is less noticeable. A typical thyratron tube drive to operate a 1-hp d-c motor from a single-phase a-c supply has a full-load power factor of approximately 80 percent lagging, calculated from readings of wattmeter and volt-

An Important Message to

Technical Men

The war has carried the manufacturing age to a new peak! Production demands have created technical problems the like of which the world has never seen before! The services of engineers are at a premium. Especially the services of one particular class—executive engineers—*engineers with business training;* engineers who can "run the show."

In these critical times, the nation needs engineers of executive ability *now, today*—not five, or ten years from now! The shortage of such men is acute—even more acute than that of skilled production workers. And company heads, aware of this situation, are offering high rewards to engineers who have the necessary training in industrial management.

Golden Opportunity for Engineers

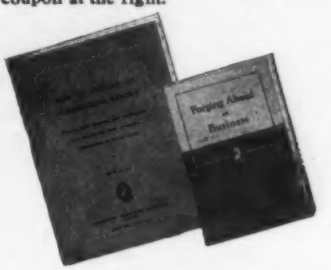
In this new era, the engineer with vision and foresight has a golden opportunity. He will realize that out of today's tremendous production battles will emerge technical men who not only will play a major role in winning the war, but who also will be firmly entrenched in key executive positions when peace comes.

However, before the engineer can take over executive responsibilities, he must acquire knowledge of the other divisions of business—of marketing, accounting and finance. He has of necessity a vast amount of technical training and experience. But in order to grasp the opportunities that present themselves today—to assume leadership on the production front—he must *also* have an understanding of practical business principles and methods.

The Alexander Hamilton Institute's intensive executive training can give you this essential business training to supplement your technical skill.

FREE help for engineers

Ever since the war began, there has been an unusually heavy demand on the part of our technically-trained subscribers for the Institute's special guide on "How to Prepare an Engineering Report". Extra copies of this practical, helpful 72-page Guide are now available and, for a limited time only, will be sent free to all technical men who use the coupon at the right.



134,000 men on the operating side of business have enrolled for this training. More than 37,500 are technical men—engineers, chemists, metallurgists—many of whom are today heads of our huge war industries.

This training appeals to engineers because it gives them access to the thinking and experience of the country's great business minds. It is especially valuable to such men because it is basic, not specialized—broad in scope, providing a thorough groundwork in the fundamentals underlying *all* business. It covers the principles that every top executive must understand. It applies to all types of industrial organizations, because all types of organizations are based on these same fundamentals.

Business and Industrial Leaders Contribute

The Institute's training plan has the endorsement of leading industrialists and business men. And it is only because these high-ranking executives recognize its value and give their cooperation that such a plan is possible. Among those who contribute to the Course are such men as Frederick W. Pickard, Vice President and Director, E. I. DuPont de Nemours & Co.; Thomas J. Watson, President, International Business Machines Corp.; James D. Mooney, President, General Motors Overseas Corp.; Clifton Slusser, Vice President, Goodyear Tire and Rubber Co. and Colby M. Chester, Chairman of the Board, General Foods Corp.

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The facts about the Institute's plan and what it can do for you are printed in the 64-page book, "Forging Ahead in Business". This book in its own right is well worth your reading. It might almost be called a handbook of business training. It is a book you will be glad to have in your library, and it will be sent to you without cost. Simply fill in and mail the attached coupon *today*.

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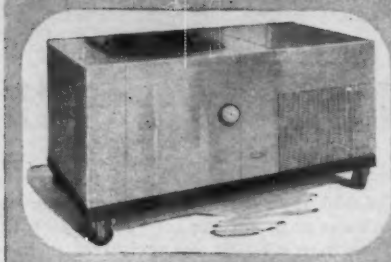

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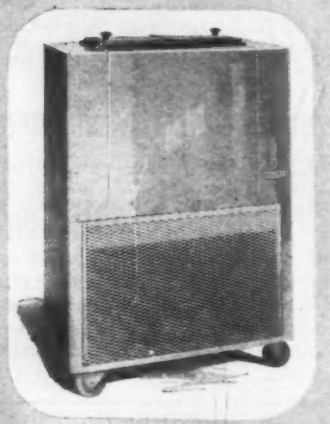
Processing of batteries, wires, and various devices is accomplished quickly and accurately with KOLD-HOLD Industrial Sub-Zero Machines. Also, use this equipment for quick-aging of steel and securing expansion fits.

Aircraft plants also use KOLD-HOLD equipment for processing and storage of 24S-T and 17S-T aluminum alloy rivets, sheets and spars. Special KOLD-HOLD units are available for testing of FT-243 crystals, for reproducing Stratosphere conditions at will, and for dual-temperature processing of sub-assemblies.

Whatever your thermal, sub-zero and Stratosphere processing and testing requirements may be, investigate the equipment that KOLD-HOLD of Lansing has designed and manufactured especially for the work involved. A card will bring you a complete catalog. Send now.



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ammeters in the a-c input circuit.

Grid phase control is a widely used method of varying the output of a thyratron rectifier by controlling the firing point of the tube during the positive half cycle of anode voltage. Briefly, this form of control consists of energizing the grid circuits of the tubes from a voltage wave which may be phase-shifted with respect to the anode voltage throughout a variable angle from 0 to 180 degrees lagging.

One form of phase-shift circuit is the inductance-resistance bridge network, or phase splitter, used in Fig. 7. Here, it is assumed that the inductive reactance of the one arm of the bridge remains constant and that the resistance of the other arm is varied to shift phase. If the resistance is zero, the output voltage of the bridge (which is the grid voltage for the tubes) will be 180 degrees out of phase with respect to the supply or anode voltage. If the resistance is many times greater than the inductive reactance, the output voltage of the bridge will approach an in-phase position. Translated in terms of output from the thyratron tubes, when the resistance arm of the bridge approaches zero resistance the thyratrons are nonconducting, and as the resistance is increased the thyratrons become conducting over a larger part of the cycle.

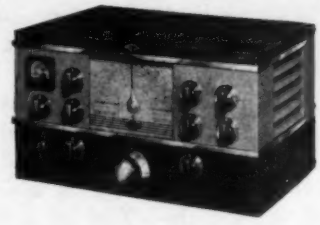
In a practical sense, the circuit of Fig. 7 is incomplete because it lacks a motor-starter control such as is included in the motor-generator drive of Fig. 6. The same magnetic control devices could be used with the electronic equipment, but having thyratron tubes to work with offers unique control possibilities if properly utilized. These tubes can be caused to hold off current flow prior to operation of reversing contactors and reestablish current flow thereafter so as to relieve the duty on the contact tips. The tubes can be made to limit the starting current automatically and to provide constant current during accelerations then automatically switch to a condition of constant preset speed after the motor has accelerated to this speed level. If the pre-set speed control has been adjusted for speeds in the field weakened region, the tube control provides full field during acceleration and automatically weakens the field, after full armature

PHOTO BY U.S. ARMY SIGNAL CORPS

LOOK FOR THE ANTENNA

Radio equipment has become the symbol of the modern instrument of war. The fast action, quick decisions and perfect coordination of today's war of movement demands perfect communications, and radio provides communication "on the move".

We are proud of the part that National Radio Equipment is playing.



NATIONAL COMPANY, INC.
MALDEN, MASS.

voltage has been reached. The armature current will be automatically limited to a predetermined value when the motor is overloaded. The speed range is extended down to very low speeds because the control maintains true speed at the present value by correcting for the internal speed regulation of the motor as well as the voltage regulation of the rectifier. If reversing is used, the tube control will act to maintain constant armature current during the decelerating and accelerating intervals and will decelerate the motor by pumping its energy back into the a-c system.

All this and more is done through the medium of grid phase control of the thyratron tubes, the phase adjustment being responsive to a sequence of control signals from a group of vacuum tubes whose individual grid circuits are responsive each to one of the various functions to be performed. How this is accomplished will be the subject of a succeeding article.

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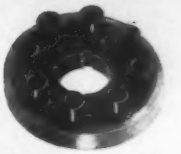
• • •

TRAINING SIGNALLERS

Many Greek boys have volunteered for the Young Soldiers Corps of the (British) Royal Corps of Signallers. This training unit is making signallers for the Army from boys who are nearly of military age. Wireless set, line operation and switchboard operation training is given after a month of training in Morse code. They are qualified to do signal work at the base after a six month training period

HOW CAN YOU TELL That it's MOLDED INSUROK?



You can tell *by the way it performs.* Appearance, alone, may be deceiving as it gives no indications of the physical or electrical characteristics of this part or one that may look just like it.

Men in ground crews, using portable floodlighting, and portable electrically driven tools know that heat and moisture have no effect on this Molded INSUROK electrical commutator. They know that it is sturdy —that it hangs on to all its intricate metal inserts like a vise.

In the development of this part, Richardson Plasticians suggested the grade of INSUROK best suited for this particular use—suggested it because it has the necessary dielectric and low moisture absorption properties—adequate heat resistance—and a good bonding reaction with the metal inserts.

Richardson Plasticians are continually recommending the grade of Molded or Laminated INSUROK best suited to meet various combinations of specifications. They will be glad to suggest the commercial or special grade which will meet *all* the conditions under which your present or plan-stage products will perform. Write for complete information.

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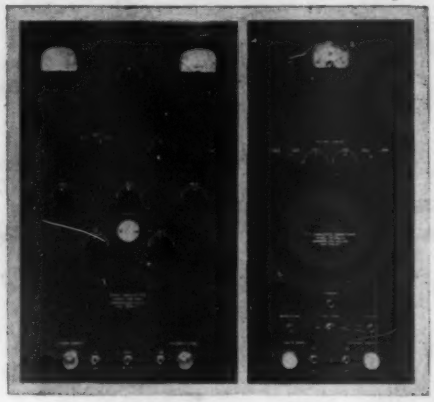
Month after month, manufacturers develop new materials, new components, new measuring equipment; issue new technical bulletins, new catalogs. Each month descriptions of these new items will be found here

VHF Transmitter, Modulator

MODEL AW-1042 radio transmitter is a low-powered, crystal-controlled, r-f unit designed for operation in the 28, 56 and 112 Mc bands. It is intended primarily for telephone or tone modulation but provision has also been made for cw telegraph keying. The unit weighs 135 lbs, is 13⅜ in. wide by 22¾ in. high by 18½ in. deep and contains its own built-in power supply, drawing approximately 490 watts from a 117 v, 60 cps line. The tube lineup consists of a pair of 855A/866 mercury-vapor rectifiers in the power supply, two VR-150-30 voltage-regulators for stabilization of crystal oscillator anode and screen potential, a 7C5-LT beam-power oscillator equipped with a 7-Mc crystal, four frequency-doublers utilizing a 7C5-LT in the first and HK-24's in the remaining three stages and pair of HK-24's in a push-pull final amplifier designed to deliver 50 watts of r.f. to a load.

Model AW-1042-A is an a-f amplifier-modulator unit which makes an ideal companion for the AW-1042 transmitter. It weighs 135 lbs, is 10¼ in. wide by 22¾ in. high by 18½ in. deep and contains its own 117 v, 60 cps power supply. This unit is equipped with a crystal microphone input jack and an a-f oscillator turning out 500 and 1,000 cps tones with provision for keying them. Output impedance is 4,000 ohms, which suits the requirements of the r-f unit with which it is primarily intended to be used. Power output is capable of 100 percent modulating the AW-1042 transmitter.

Hammarlund Manufacturing Co., Inc., 460 W. 34th St., New York City.

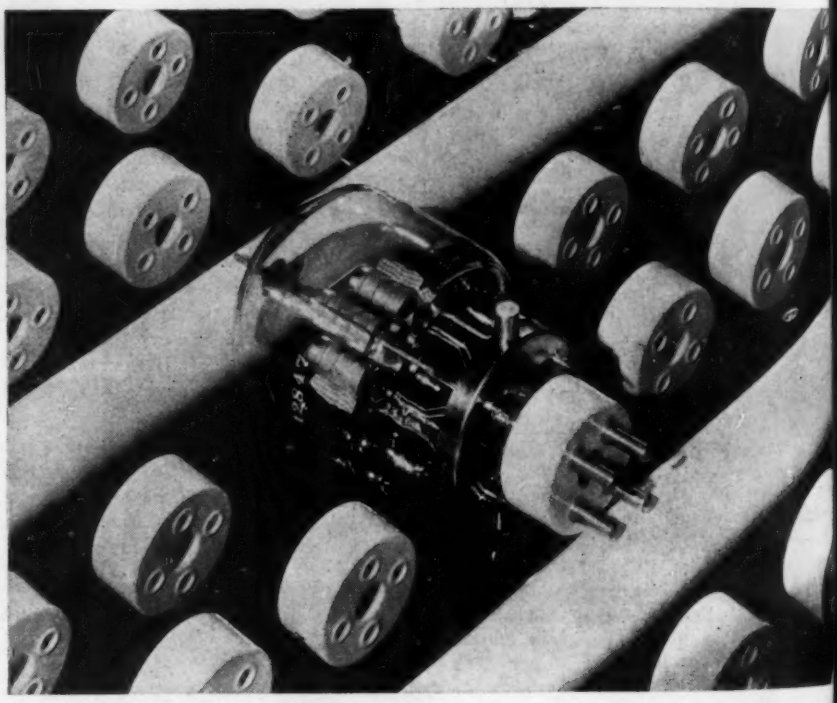


Hammarlund companion units

New Ceramic Plastic Used for Radio Tube Bases

A NEW PORCELAIN, called Prestite, is made from raw materials found in quantity in this country. The porcelain material is a development of Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. Its use as a base for high frequency radio tubes for military communication equipment has been adopted by Heintz & Kaufman, Ltd., South San Francisco, Cal., to replace material formerly used in manufacturing bases and now on the critical list. Heintz & Kaufman state that adapting the ceramic plastic to production created no major problem and that no engineering design changes were necessary, and that the material possesses satisfactory mechanical and electrical strengths and meets performance specifications with a high dielectric strength and a loss factor better than Navy Grade F requirements. The tube, illustrated, is a standard commercial high frequency radio part which functions as an electronic relay governing the storing and releasing of as much as 12,000 volts of electrical energy at a rate of 1000 pulsations a second. The base withstands this voltage surge and faithfully permits measured current interruptions without undue heating.

The new compound has a slightly higher loss factor than material formerly used, but its insulation requirement is more than is necessary. Under load tests the manufacturer states Prestite bases withstand more voltage than their ratings show, and



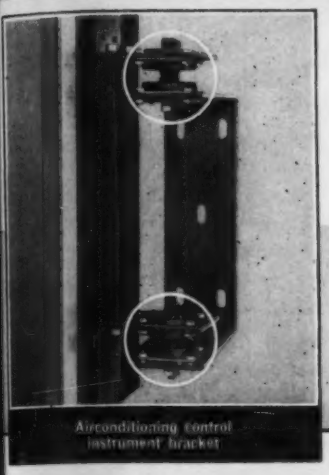
Westinghouse Prestite bases for radio tubes manufactured by Heintz & Kaufman

DESIGNING for use of . . .

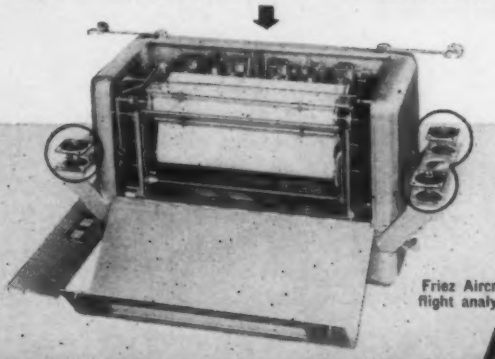
LORD MOUNTINGS

BONDED RUBBER

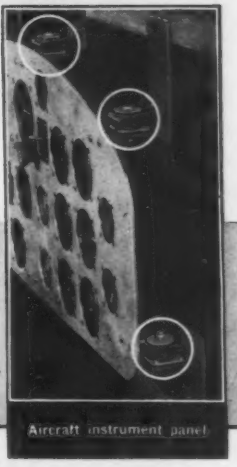
TYPICAL INSTALLATIONS OF ⬅ LORD PLATE FORM SERIES MOUNTINGS ➡



Airconditioning control instrument bracket



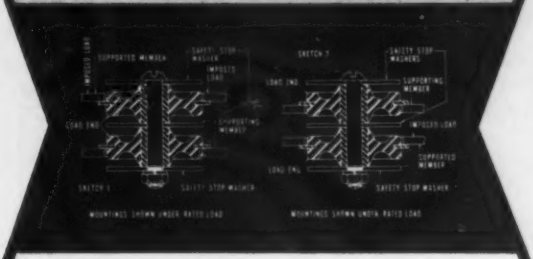
Friez Aircraft flight analyzer

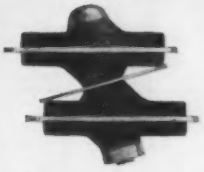


Aircraft instrument panel

Series mounting using center spacer, allowing greater lateral movement

Standard square plate form series mounting





Standard series mounting under load and in extreme lateral movement position. Note snubbing washer

Combination square plate form and holder type series mounting

LORD Shear Type, Bonded Rubber Mountings isolate vibration, absorb shock, minimize noise translation. They are compact, sturdy, light weight, and ease of installation is an important feature. Lord standard mountings are made in tube form and plate form, in various shapes and many sizes, and with load ratings ranging from a few ounces to 1500 pounds. They are designed for application on all types of mechanical and electrical devices from delicate instruments to massive equipment.

When mounting extremely delicate or sensitive equipment, the use of mountings in series is recommended. Lord mountings in series are formed by connecting the center sleeves of two single units as shown in the illustrations. In operation a series mounting arrangement: (1) Doubles the axial deflection and (2) Greatly increases the lateral softness of the mounting system.

The resultant effect of the increased deflections in all directions is a marked decrease in the natural frequencies of the mounted system and practically complete isolation against the harmful effects of vibratory forces. The degree of lateral softness may be varied by inserting spacers between the mounting units; increasing the distance between the mountings increases the lateral movement for any given force.

Illustrations show typical methods of installation and application. To install Lord mountings in series, provide recessed hole 1/32" larger than rubber diameter in both the *Supported* and *Supporting* members, for clearance. Drilled, punched or tapped holes should be provided for fastening.

Sketch No. 1 shows the simplest arrangement of series mounting, the lower unit being fastened to the *Supporting* member and the upper mounting is fastened to the *Supported* member. Sketch No. 2 shows a type of series installation where the *Supporting* member is attached to the upper mounting, and the *Supported* member or imposed load is attached to the lower mounting. This method is often used in conjunction with method shown in sketch No. 1, where several points of suspension are necessary. The aircraft panel illustration shows typical example, sketch No. 1 arrangement being used at base of panel and sketch No. 2 arrangement at top.

Series mounting arrangements can also be made up by using a Standard Plate form mounting in conjunction with a Holder Type mounting, eliminating the necessity of recessing the member where holder base is fastened.

The use of snubbing washers as shown is recommended. They prevent excessive movement under shock loads, either vertically or transversely without interfering with normal operation. The metal washer between the two mountings may be eliminated when a center spacer is used for greater lateral freedom.

Complete information on dimensions, load rating and methods of installation are contained in our Bulletin 104. Send for your copy.

LORD MANUFACTURING COMPANY . . . ERIE, PENNSYLVANIA

Originators of Shear Type Bonded Rubber Mountings

SALES REPRESENTATIVES · NEW YORK, 280 Madison Ave. · CHICAGO, 520 N. Michigan Ave. · DETROIT, 7310 Woodward Ave. · BURBANK, CAL., 245 E. Olive Ave.

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1¾ and 2 Pound Capacity Solder Pots

—designed for tinning small wires and leads with maximum efficiency and minimum cost in radio, motor and other electrical equipment plants where individual solder pots are desired for each operator. A single-heat, porcelain nickel-chrome heating element, which can be quickly and inexpensively replaced when necessary, heats the pot. Operates on 110 v., a.c. or d.c.—or 220 v. if requested. Ruggedly constructed for long, dependable service.

Complete information furnished on request

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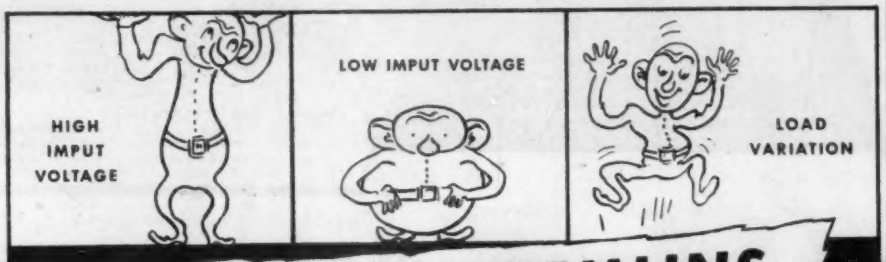
5127 W. 25th Street, Cicero, Illinois



BEAT THE GREMLINS of fluctuating Voltage with RAYTHEON VOLTAGE STABILIZERS

- CONSTANT A. C. OUTPUT VOLTAGE ± ½%.
- QUICK ACTION... stabilizes fluctuating voltage instantly. Variations can't be observed on ordinary volt meter.

Stabilizer with cover removed

- WIDE A. C. IMPUT VOLTAGE LIMITS... 95 to 135 volts—single phase. ENTIRELY AUTOMATIC—NO MOVING PARTS. Connect it. Forget it.
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RAYTHEON MANUFACTURING Company
190 WILLOW ST. WALTHAM, MASS.

no changes in other parts of the tubes are necessary. Prestite combines the electrical and mechanical strength of wet process porcelain with the moulding qualities of dry process porcelain. It is formed under heavy hydraulic pressure that imparts a dense grain structure, enabling it to stand electrical, mechanical, and chemical abuse. It is used in many products where intricate shape requirements must meet demands for high insulation.

• • •

Lightweight Thyratron Tube

FOR APPLICATIONS where weight and space are a consideration, a new thyratron (GL 502) with both a control and a shield grid for control applications is available. The tube is a little over 2½ inches long, weighs about 2 ounces, is inert-gas-filled and of all-metal construction. It may be used in industrial welding or general control equipment. Some of its characteristics are high sensi-

tivity, control characteristics practically independent of ambient temperature over a wide range, relatively unaffected by line-voltage surges, maximum peak inverse anode voltage rating of 1300 volts, instantaneous current rating of 500 ma, and an average current rating of 100 ma. The quick-heating cathode is rated at 6.3 volts, 0.6 amp.

Tube Div., General Electric Co., Electronics Dept., Schenectady, N.Y.

• • •

X-Ray Intensity Meter and Radiographic Exposure Control

METER X IS A PORTABLE, direct-reading indicating instrument which may be used for studying the intensity and uniformity of primary beam, effect of filters, pattern of stray or secondary radiation or for establishing radiographic and photo-fluoro-

raphic technique for new processes r for mass radiography; for standrdizing absorption constants; and s a safety device to warn an operator against a region of excessive adiation. The meter illustrated consists essentially of an ionization hamber and amplifier of high curent sensitivity connected by a hielded cable (the standard length 10 ft., but can be increased to 30 t., if necessary) to a box that conains batteries, control elements and he indicating meter. The meter can e placed in a sheltered spot, while he ionization chamber is in the -ray field. With a 68 cu. cm. alumnum ionization chamber, the sensiivity of the meter in diagnostic volage range is about 0.0005 Roentgen er minute per ma. The sensitivity ncreases with higher voltage. The nstrument is shielded from electrotatic pick-up and stray capacity is inimized to increase the speed of esponse.

ADIOGRAPHIC EXPOSURE CONTROL, Meter R, is a device which can be adusted to automatically de-energize he x-ray generator when the proper uantity or dosage of rays have eached the film. It is directly applicable to diagnostic and industrial adiography, where objects to be -rayed differ from time to time and pecially where thoroughly trained echnicians are not available. It assures radiographic images of proper

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to New War Developments

Ships, planes, tanks and the forces in the field depend on the constant performance of Electronic Instruments for coordination by communication, detection, controls and other war winning developments.

Transformers that are little and tough—designed and constructed to meet the most unusual requirements and conditions—are a vital part of these devices.

There is never an hour, day or night, around this war-torn world that Transformers are not helping to win this war by being an important part of the Electronic Units that are doing so much to aid the Armed Forces.

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BELL SOUND SYSTEMS

Official U. S. Navy Photo

Spectacular strides — as spectacular as the mosquito boat's record — have been made in applying electronics to war needs. But it wasn't an overnight job! Years of work, study, research and experiment came first. That's why Bell Sound Systems were so quick to contribute so much to wartime needs — Bell was among the first to probe the future of electronics by applying its principles to practical jobs . . . by pressing ahead with new ideas and improvements. Bell technicians gained years of priceless experience, and were ready to meet the new demands.

The electronic wonders that BELL Sound Systems are performing in war, promise even greater advances in sound amplification, transmission and recording for tomorrow. And BELL Sound Equipment will play as aggressive a part in peacetime progress as it has in furthering electronics' contribution to Victory!

BELfone inter communication systems offer every type of service for *instant speaking* contact between all executives in any business firm or manufacturing plant—or between individual executives and any number of subordinate stations. Write for details.

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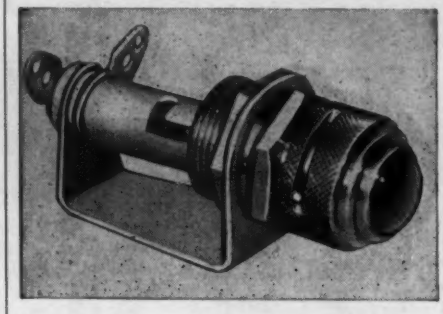
density and permits standardized processing. The meter may be built to cut off rays or give a signal at dosages of from 0.003 Roentgen up for exposures less than ten minutes. (Dental film darkens measurably at 0.05 Roentgen. Non screen film darkens to a density of 1.4 when exposed to about 0.1 R.) The type R meter is similar in external appearance to type X.

Both instruments are available from Electronic Control Corp., 626 Harper Ave., Detroit, Mich.

• • •

Shutter-type Pilot Lights

NEW SHUTTER-TYPE pilot lights (which are particularly suited to aircraft, marine, signal and similar applications where various intensities of light are desired under constantly changing conditions) permit a gradation of light from bright, through intermediate glows, to total dark with 90 deg. rotation of the



shutters. Known as the Gothard Model 430 (with faceted jewel) and Model 431 (with plain jewel) these lights are available with red, green, amber, blue or opal lens or with a polarized lens. A catalog which covers styles and models available for immediate shipment may be obtained from Gothard Manufacturing Co., 1300 N. Ninth St., Springfield, Mass.

• • •

Oscillograph for Expanded Frequency Range

A 5-INCH SCREEN size together with the inclusion of a Z-axis amplifier to modulate the beam with any signal applied to its input terminals or with a return trace blanking impulse produced by the linear time-base generator, distinguishes this new Type 241 cathode-ray oscillograph from Type 224, announced in January, ELECTRONICS. The oscillograph has a uniform Y-axis or vertical deflection response from 20 cps to 2

"dag" COLLOIDAL GRAPHITE

ITS PROPERTIES

An electrical conductor
Low in photoelectric sensitivity
Diamagnetic
A black body
Low coefficient of expansion
Gas absorbent
Opaque
Chemically inert
A conductor of heat

ITS USES IN ELECTRONICS

Vacuum tubes
Ray focusing anodes in cathode ray tubes
Shields
Grids, radio
Plates, radio
Electron guns
Nonmetallic electrodes
Glow discharge tubes
Luminous gaseous discharge lamps
Experimental cells
Converter and output tubes
Electron multipliers
Half wave rectifiers
Three element discharge devices
Photoelectric cells
Counter electrodes
Resistances
Thermopiles

ACHESON COLLOIDS CORPORATION
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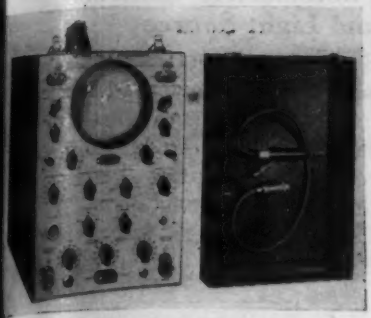

...c. The X-axis or horizontal deflection amplifier has a uniform characteristic from 10 cps to 100 kc. Both amplifiers have distortionless input attenuators and gain controls. Provision is made to connect signals directly with the deflection plates when frequencies to be observed are beyond the useful limits of the amplifiers.

The instrument case has a removable front cover. The removable test probe, held inside the cover by clips, consists of a compensated 10:1 attenuator mounted in an insulated probe and supplied with a 3-foot length of coaxial cable and connector. This design permits connections to relatively high impedance circuits without serious loading, while minimizing stray pickup. Self-contained, operating directly on 60 cps, 115 volts, a.c., the instrument weighs 65 lbs and measures 17½x10½x21 inches.

Allen B. DuMont Labs., Inc., Passaic, N. J.

Megohm Decade Box

No. 915-A megohm decade box is a single dial box, consisting of ten 1.0 megohm resistors, connected in series, mounted on steatite insulators. These resistors are thoroughly impregnated so that the calibration is not affected by high humidity. Each resistor is capable of dissipating two watts; except in work requiring closer tolerance when the dissipation should be held to one watt per unit. The resistors have a standard accuracy of ±0.05 percent at 74 deg. F. The instrument (which is housed in a metal box, and which may be furnished completely shielded) may be immersed in an oil bath, for work demanding extreme accuracies, increased dissipation, or both. A maximum of 10,000 volts may be applied across the binding posts. Standard 2 and 4 dial resistance boxes are available.

Shallcross Mfg. Co., Collingdale, Pa.

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Line up the performance requirements of your current production against this convenient checklist.... See for yourself how you can help your war effort with one or more of these important plastic characteristics:

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- ☐ CLOSEST TOLERANCES — *engineered accuracy*
- ☐ INTRICATE FABRICATIONS — *undercuts, special threads, etc.*
- ☐ TENSILE STRENGTH — *to highest test points*
- ☐ WEIGHT CONSERVATION — *where material reductions must be made*
- ☐ LIGHT CONDUCTION — *where indicator and other signals must carry to remote points*
- ☐ COLOR RANGE — *many-hued plastics offer important identification values.*

If you could use parts with these characteristics, check with Creative on fast plastics production — without costly, time-consuming molds. Rush blueprints or samples. *Illustrated folder sent on request.*

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AND LOTS OF IT

★ Transformers for Combat

In Active Service Over the Entire Globe

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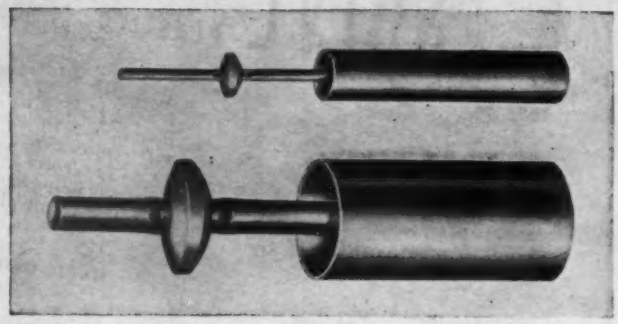
ANDREW

COAXIAL CABLES



. . . for Radio Transmission Lines

The VICTOR J. ANDREW CO., pioneer manufacturer of coaxial cables, is now in a position to take additional orders, in any quantity, for all sizes of ceramic insulated coaxial cables and accessories. The Andrew Co. engineering staff, specialists in all applications of coaxial cables and accessories, will be pleased to make recommendations to meet your particular requirements.

"Attention!"

If coaxial cables are your problem . . . write for new catalog showing complete line of coaxial cables and accessories.

ANDREW

VICTOR J. ANDREW CO.

363 East 75th Street, CHICAGO, ILLINOIS

ANTENNA EQUIPMENT

Photoelectric Controls and Light Sources

SERIES 70 PHOTOELECTRIC controls a adaptable to a variety of applicatio in control problems. In cases whe separate mounting of photocell a control is mandatory, Series 70 m be used in conjunction with any three phototube units availabl Model 76 uses a 2-tube amplifier a

is designed for applications requi ing high sensitivity. Model 72 o erates on a minimum of 4 ft. candle while Models 74 and 76 are rated a ½ ft. candles. Contact capacity of a four units is rated at 3 amps. Fo additional cost infra-red filters ar available, as well as a non-inductiv microswitch for mounting on th sensitive relay to increase the co tact capacity to 10 amps.

SERIES 18 LIGHT SOURCES are supplie in two types (both of which hav lens focal lengths of 2, 4 or 6 inches) Model No. 18-A comes without transformer and the operating cu rent is supplied by the control. I

is rated up to 32 candle-power model No. 18-B comes with a trans former and operates directly fro 110 volts, a.c. Model 18-B is provide with taps to permit operation a various light intensities. It is rate up to 50 candle-power.

United Cinephone Corp., Torring ton, Conn.

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If you are businessman enough to realize, and want to capitalize on, the opportunities that are now available to every engineer who wants to take advantage of them . . .

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Producers of Well-trained Technical Radiomen for Industry

Water-proofing Chemical for Ceramic Insulators

"DRI-FILM" IS a new chemical compound whose vapors will make cloth, paper and other materials water-repellent. This was developed by Dr. Winton I. Patnode of G-E Research Laboratory and will be marketed by Electronics Department of General Electric Co., Schenectady, N. Y. One of its most important uses is in the treatment of ceramic insulators for

radio equipment. It is approximately nine times more effective than wax, or varnish. Dri-film is a clear liquid composed of various chemicals which vaporize at a temperature below 100 deg. C. Articles to be treated are exposed in a closed cabinet to the vapors for a few minutes. Then they are taken out and, if necessary, are exposed to ammonia vapor to neutralize corrosive acids which may collect during treatment.

High Voltage Plate Supply Transformer

AN ARMOURED-INSULATION high voltage plate supply transformer which minimizes the affects of high voltage aging is available at a rating of 1.8

amps secondary, 3300 volts. The unit is sturdily constructed and is for transmitter service for d-c rectifier systems.

The Acme Electric & Mfg. Co., Cuba, N. Y.

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The TIME YOU LOSE on Slow Deliveries of RADIO & ELECTRONIC Supplies

DON'T let slow deliveries of radio and electronic supplies rob you of precious time on vital war work! Now you can often save days, even weeks, with "W-J Emergency Service!" Whether it's one or a hundred items, made by many different manufacturers, you have only one order to write, one dependable source to look to for speedy, efficient service. Here at W-J we've established a special war emergency service that "delivers the goods" faster than you would believe possible under present material shortage conditions. Unusually large, diversified stocks; picked technical staffs; special handling . . *every facility* provided to eliminate delay and to help you maintain working schedules. Phone, wire, or mail your orders. See what we mean by EMERGENCY SERVICE!

Free This reference book and buyer's guide is a valuable asset. It's packed with information on Radio and and Electronic products. Sent free to Purchasing Agents and others responsible for buying who write for a copy on company stationery.

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W-J — RADIO AND ELECTRONIC SUPPLIES — WALKER-JIMIESON, INC. CHICAGO

"...IN-RES-CO resistors for stability plus"

★ Lower production costs are possible when specifications call for IN-RES-CO wire wound resistors. Purchasing agents, designers and manufacturers realize that substantial economies can be effected by using specialized IN-RES-CO units. These application-designed products offer exceptional operating dependability and efficiency, with no cost premium for their higher quality.

Write today for literature describing the complete IN-RES-CO line of fixed and variable resistors, meter shunts, chokes, multipliers, etc.

TYPE SB, (at top), 1 Watt, Non-inductive, Standard tolerance ½%. Maximum resistance 1 megohm, Size 9/16" diam. x 1" high.

TYPE RB (bottom), ½ Watt, Non-inductive, Standard tolerance ½%. Maximum resistance 500,000 ohms, Size 9/16" diam. x ½" high.

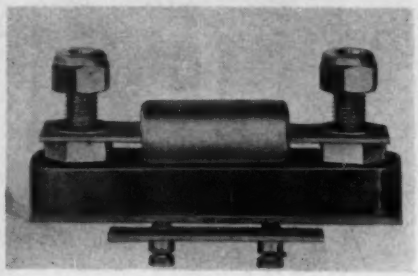
IN-RES-CO

INSTRUMENT RESISTORS COMPANY

25 AMITY ST., LITTLE FALLS, N. J.

Electrical Fault Limiter

THIS ACCESSORY is designed to protect aircraft and other electrical circuits against damage from short circuits. It does not clear ordinary overloads, and in no way limits the amount of current that passes through the circuit, but only limits the duration of heavy overload currents. It carries its nominal current rating indefinitely. When fault currents in the order of 4-to-5 times rated current are encountered, the limiter will clear the line promptly. It is normally installed in series with the reverse current relay, and when



the reverse current relay fails to operate, the limiter clears the circuit, thereby preventing fires and the spreading of the fault. Another application is in protecting aircraft electrical circuits in multi-engined craft. Sectionalization of the circuit with fault limiters isolates the fault and prevents other sources of current from perpetuating it. These fault limiters are approved for use on aircraft, are lightweight and are made in several ratings. Type FLS is illustrated.

Burndy Engineering Co., Inc., 459 East 133rd St., New York, N. Y.

Electronic Level Control

A NEW SERIES of electronic level controls designed particularly for hazardous location mounting includes Type P15NHX (for high-level control) and Type P15NLX (for low-level control). The equipment is for use with conductive liquids of an explosive nature. Each model is furnished as a complete unit in a vapor-proof cast-iron housing for direct tank installation. High-level control is accomplished when the liquid rises and contacts a probe tip; low level control is accomplished when the liquid drops below the probe tip. Both models incorporate a safety feature for operation of the

PERMANENT MAGNETS

New Steels and New Processing Methods are producing BETTER MAGNETS

WITHIN the past few years, rapid progress has been made in the practical application of permanent magnetism. Much more is known about the subject. Designs of magnets have been improved. Better steels are available. Processing is more precise and under better control.

We'll be glad to help you design your permanent magnets to provide greater energy content.

★ ★ ★

Among the steels we frequently use are ALNICO and NIPERMAG, two very satisfactory steels for permanent magnets. Their higher power permits substantial economies in design.

ARMY E NAVY

5-CC-1

CINAUDAGRAPH CORPORATION

STAMFORD, CONNECTICUT

lay in case of current or tube fail-
re. The relay connections of Types
15NHX and P15NLX are those of
single-pole double-throw switch.
he relay contacts are rated at 1000
atts a.c. Both models are available
r operation on 230, 208 or 115
olts, a.c., 60 cps.

Photoswitch Inc., 21 Chestnut St.,
ambridge, Mass.

utomatic Voltage Tester

THIS DEVICE has no meter, no switch-
g or tip jacks. It reads like a
ermometer. Utilizing neon lamps
connection with resistance net-
orks, the unit will indicate on any
requency or type of current; can be
sed to test opens or shorts, etc.
is used by connecting needle-

ointed prods across the line or part
question. It utilizes less than a
illiampere of current, requires no
ccessories and is a general "bang-
round" type of instrument. It is 5
ches high, 1¾ inches wide and is ¾
ches deep. Weight, approximately
lbs.

Superior Instruments Co. Dept.
, 227 Fulton St., New York, N. Y.

For Circuits that

MUST NOT FAIL

KESTER CORED SOLDERS

In the hundreds of vitally important jobs where solder is used today in production of war equipment, there can be no compromise with quality. Only solder that holds with bulldog grip—that *won't let go*—is good enough for the exacting work of war!

Kester Rosin-Core Solder protects electrical circuits for communication and control against service difficulties of every sort. The patented plastic rosin flux won't cause corrosion or injure insulating material. Kester Rosin-Core Solder holds tight under vibration, bending, shock, and expansion and contraction of temperature extremes. Expedites production, too, because alloy and flux, in just the right amount, are applied in one sure, simple operation.

Kester engineers will gladly assist you with any production problem involving solder. Write fully, without obligation.

KESTER SOLDER COMPANY
4204 Wrightwood Avenue, Chicago, Illinois
Eastern Plant: Newark, N. J. Canadian Plant: Brantford, Ont.

莊周子

PRINCE HUEI admired the skill of his cook in cutting up a bullock. "Sire," replied the cook, "a good cook wears out a chopper once a year—an ordinary cook one a month. But I have had this chopper nineteen years, and its edge is as if fresh from the whetstone."

—*CHUANGTSE, The Preservation of Life*

The Erwood organization may likewise point to its experience—over twenty years in the electronics field.

We like to do the difficult jobs. Today we are fully engaged in doing just that for the war effort. When peace comes, this experience will be available to you in the new and changed electronics era which lies ahead.

The Erwood Company

223 WEST ERIE STREET • CHICAGO, ILL.

The most widely used Plugs and Jacks in the U.S.A.

These are only three of the many items now rolling off our production lines. We are equipped to manufacture plugs and jacks to your specifications . . . send us your blueprints for quotations.

ARHCo

Keep Buying War Bonds

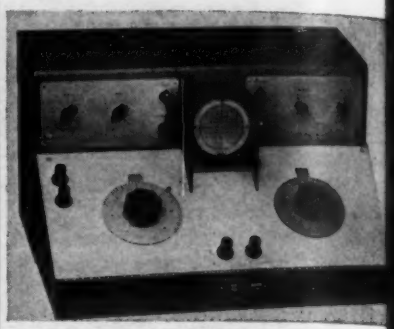
American Radio Hardware Company, Inc.

476 BROADWAY, NEW YORK, N. Y.

MANUFACTURERS OF SHORT WAVE • TELEVISION • RADIO • SOUND EQUIPMENT

Impedance Matching Bridge

THIS UNIT will test all coils (r- antenna oscillators, i-f transformer etc.) having inductance lying be tween 0.0025 mh to 50.0 mh. The pe centage of accuracy may be adjuste between 3 percent to less than 0.0 percent. It provides a fast, accurat method for adjusting and checkin coil inductances in production work The bridge consists of an oscillato amplifier, bridge proper and cathod ray indicator. It will compare ca pacitances and resistors; the se up can be changed over quickl from one coil to another; slide wire



of rugged design are included oscil lator and amplifier circuits are per meability tuned and have silver-mic condensers to minimize frequenc and phase shift; visual method of in dication reduces operator fatigue only fixtures and jigs are require for connecting different coils to th test terminals; and finally, variou parts of the unit are readily avail able for periodical inspection.

Radex Corp., 1733 Milwaukee Ave Chicago, Ill.

Air-Cooled Distribution Transformers

SIMPLIFICATION in installation an reduced initial and operating cost are some of the features claimed fo the new type distribution trans formers which utilize air-cooling instead of, for instance, oil as an in sulating and cooling medium. Sinc fire and explosion hazards are elim inated, the transformers may be lo cated anywhere indoors without th need of a protective vault, or th unit may be placed near its loa center. Inspection and maintenanc are simplified because valves, cooling tubes, liquid level guages and ga kets have been eliminated in th construction of the transformer

MIRACULOUS MINUTENESS in EMBY Selenium

Instrument Rectifiers Engineered for Engineers

EMBY Instrument Rectifiers ve specially treated metal electrodes and use uni-polar conductivity of metal to seleni- junction. Rectification is instantaneous—no rm-up period required. No moving parts. ack proof. Permanent characteristics. Unlimit- life. Increased efficiency with increased tem- rature. Temperature range, —70 to +70°. affected by severe atmospheric conditions. aled-off units supplied for aircraft service. ries "N" and "S" have satisfactory frequen- characteristics and can be used in the fre- ncy range up to 100 kc.

N-2

Input 5 volts. Half wave. Continuous dc current 1 ma. Used with meters, detector circuits, bias voltage.

H-SM

Input 5 volts. Half wave. Continuous direct current 8 ma. Numerous field applications.

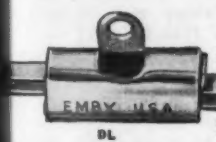
B-SM

Input and output same as H-SM, but has two rectifying elements connected in series.

Input 10 volts. Full wave Bridge. Continuous dc 10 ma. Unbreakable plastic case with mounting extension.

CENSORED

Input 10 volts. Full wave. Continuous dc rating 35 ma. Mounted in



DL

Input 10 volts. Full wave Bridge. Continuous dc rating 35 ma. Mounted in aluminum case with mounting extension.

Input 10 volts. Continuous dc rating 50 ma. Mounting ex- sion avail-

ATIONS ACTUAL SIZE

d for Bulle.. complete specifications. (Bulletin 10 on Self-gene.. Photo-Electric Cells is also ilable.)

ELENIUM CORP. OF A..

Manufacturers of EMBY Rectifiers, Photo-Electric Cells and allied scientific products

1800-1804 West Pico Blvd. Los Angeles, California

The unit is also light and compact and requires no headroom. It is constructed throughout with class B, heatproof insulation consisting of fiber glass, mica, asbestos and porcelain. The transformers are available up to 500 kva; in voltages to 4800 volts, single phase, three phase, and Scott connected 3 to 2, or 2 to 3 phase, in one unit.

Eisler Engineering Co., 740 South 13th St., Newark, N. J.

Multitesters

MODEL 461 MULTITESTER has a sensitivity of 20,000 ohms per volt on all d-c scales. The sensitivity on a-c scales is 1,000 ohms per volt. The instrument has a 4½-inch rectangular meter. Measurements of 1 ma

are obtained on the 100-ma scale. ..nts and matched pair metalized ge multipliers are rated as hin 1 percent accuracy. The ctifier is a copper oxide type. verall dimensions are 7 x 5½ x 3 nches, and the instrument is supplied complete, with self-contained battery supply.

Model 419 multitester is a combination a.c-d.c. voltmeter, milliameter, ammeter, capacitymeter, ohmmeter

Quiet, Archimedes

Stop shouting, "Eureka" . . . If we yelled each time we found a few things, this little town would need more than an anti-noise ordinance.

Every day, our staff, trained by many years of experience in purchasing and supplying technical radio parts, locates hard-to-find equipment that is needed in vital war jobs. *In some instances, we can make immediate deliveries from the wide range of apparatus and components, saved from our normal pre-war stock for just such emergency orders.* However, if the components are not on our shelves, we can quickly locate the source of whatever material you require, and expedite these deliveries.

"Hit-and-miss" methods of searching are costly. We can save both time and expense. Let Harvey *find it* for you.

INSULATING VARNISHES
VITAL TO MP'S OF THE AIR

Above the clouds, you will find DOLPH'S Insulating Varnishes serving our flag by protecting the electrical control units of the MP's of the Air. A mere film of insulating varnish, only a few mils thick, is playing an important part in "delivering the goods" to the Axis.

When in need of insulating varnishes, specify DOLPH'S and assure yourself that your electrical units are getting extra protection.

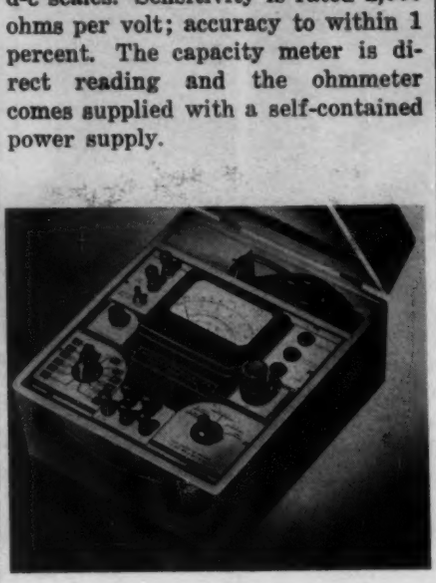
DOLPH'S VARNISHES PROTECT THESE AIRPLANE CONTROL UNITS:

Radio Dynamotors
Solenoid Starting Relays
Unshielded Battery Booster Coils
Landing Gear Control Units
Remote Indicating Autosyn Units
Variable Pitch Propeller Controls
Ignition Coils—Generators
Inverters—Starters

MANUFACTURERS OF
CHINALAK and SYNTHITE Insulating Varnishes
DOLCOTE Cable Enamels

JOHN C. DOLPH COMPANY
Insulating Varnish Specialists
169-A Emmet St., Newark, New Jersey

and inductance meter, and is built without the use of a copper oxide rectifier. A-c scales are linear with d-c scales. Sensitivity is rated 2,000 ohms per volt; accuracy to within 1 percent. The capacity meter is direct reading and the ohmmeter comes supplied with a self-contained power supply.



This particular model is available in three types which include Model 419P (supplied in a case), Model 419C (open face bench type with an 4½ inch meter), and Model 319V-7 (an upright instrument).

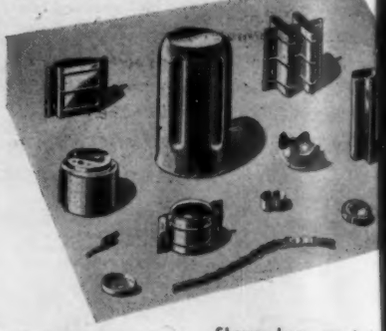
Radio City Products Co., Inc., 127 West 26th St., New York, N. Y.

• • •

Vibrating Reed Frequency Meters

VIBRATING REED frequency meters are for use on engine generator sets, in labs, telephone, television, radio service, as well as in many types of electronic equipment. The meter consists, of a dial, central mounting frame, series of spring steel reeds, reed mounting bar, individual driving coil, permanent magnet surrounding each bank of reeds, a series resistor, and terminal studs. In operation, the alternating current (or interrupted direct current) excites the driving coil. As each reed is adjusted to respond by resonance to but one frequency, the one reed "in tune" with the frequency in the coils will respond by vibrating rapidly because of polarization by the permanent magnet, and induced magnetism from the coil. A series resistor adapts the instrument to specified operating voltage. The frequency of the current can be read opposite that reed on the graduated face of the instrument. If the frequency is frac-

Stamping Grounds
for ELECTRONIC TUBE PARTS and SHIELDS



Shown here are just a few typical samples of GOAT Electronic Tube Parts and Shields that have been stamped, drawn and formed on GOAT machines, dies and presses.

SMALL TOUGH JOBS . . . handled with skill, precision and efficiency, are a regular part of GOAT Service. GOAT'S position today, as largest independent manufacturer of electronic tube parts, is due to GOAT'S experience and growth. From the days of radio infancy, GOAT has been able to design and improve the parts needed by this industry as it demanded greater sensitivity and durability as well as quantity production.

Today, GOAT serves almost every electronic tube manufacturer with a tremendous variety of stock parts. Facilities are so complete that GOAT actually can supply any kind of small metal stamping, made in any metal, to any required degree of accuracy.

GOAT METAL STAMPINGS, Inc.
Division Of THE FRED GOAT CO., INC.
Machinery Specialists since 1893
314 DEAN STREET, BROOKLYN, N. Y.

tional, for example, 60.5 cps—the 60 cycle reed will vibrate to about half its full amplitude, and the 61 cycle reed will vibrate similarly.

Some of the features claimed for the instrument include: full and half cycle increments; sharp or broad response; power consumption average less than 2 watts and as low as ½ watt; voltage range from 8 volts up, depending on the model (an external series resistor is used above 500 volts); combination of reeds are available in frequency ranges of 20 cycles, or up to 425 cycles, (lower or higher ranges are available for special services); accuracy is ±0.3 percent on full cycle increments, ±0.2 percent on half cycle increments (both at normal temperature); the instrument is not affected by wave form, normal temperature changes, or external magnetic fields.

Bulletin VF-43 contains complete information on the meters, and is available from the manufacturer, J-B-T Instruments, Inc., New Haven, Conn.

Magnifying Scale

"MICRO-SCALE" is a new magnifying scale for use in laying out tools and dies; measuring piece parts, checking tools, etc., in defense plants. It consists of a standard machinist's scale divided into 64th of an inch, and a magnifying attachment. The magnifier is a patented plastic lens mounted on a slide block which is used to check the length of parts, depths of holes, center distances in layouts, finishes of metal, etc. The scale will lie flat when carried in a pocket.

Leonard Engineering Company, Capitol View, Silver Spring, Md.

Percentage Timer

THIS INSTRUMENT automatically controls the percentage of time at which any a-c circuit can periodically be closed or opened out of a definite length of a time cycle. It is particularly applicable where one function bears a definite time relation in percentage or operation of a second function such as to regulate any input to electrically operated furnaces, ovens or heaters; controlling the proportionate, flow of chem-

S·S·White
for
FLEXIBLE SHAFTS

An Important Factor in Radio and Electronics

S. S. White Flexible Shafts are fitting in effectively in many radio and electronic developments—in some cases, for transmitting power—in others, for providing remote control—and in still others, as a means of centralizing controls while permitting controlled members to be placed in positions most desirable from the standpoints of circuit efficiency and ease of assembly and servicing.

S. S. White offers the widest range of flexible shaft sizes and characteristics in both the power drive and remote control types—also flexible casings and shaft and casing end fittings.

DATA FOR ENGINEERS

BULLETIN 1238—Power Drive Flexible Shafts.

BULLETIN 38-42—Remote Control Flexible Shafts.

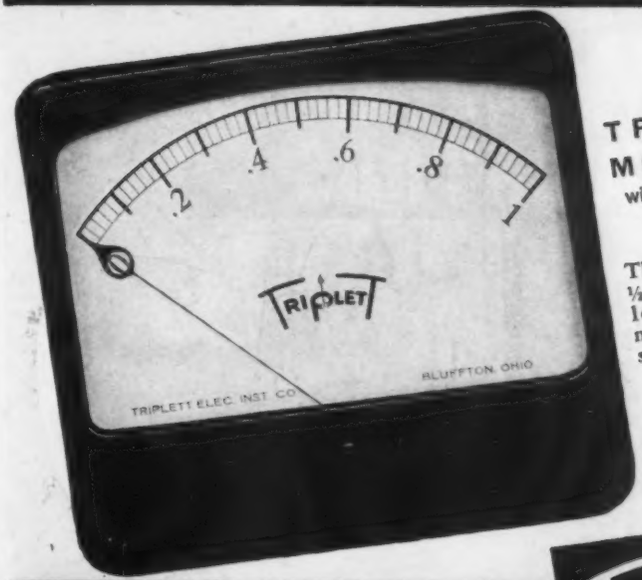
Copies mailed to you on request

CONSULT S. S. WHITE
when you need flexible shafts. Also for engineering aid in selecting and applying flexible shafts for any remote control or power drive application. At present, of course, our products and services are confined to work connected with war production.

ARMY E NAVY

S. S. WHITE
The S. S. White Dental Mfg. Co.
INDUSTRIAL DIVISION
Department E, 10 East 40th St., New York, N. Y.

TRIPLETT
Combat Line INSTRUMENTS



TRIPLETT
MODEL 626
with long 5.60"scale

★

This illustration is ½ actual size. Note long scale and minimum panel space required.

A WORD ABOUT DELIVERIES
Naturally deliveries are subject to necessary priority regulations. We urge prompt filing of orders for delivery as expeditiously as may be consistent with America's War effort.

TRIPLETT ELECTRICAL INSTRUMENT CO. . . . . BLUFFTON, OHIO

Important INFORMATION ON...

for

MARINE • AIRCRAFT • SIGNAL CORPS and INDUSTRIAL APPLICATIONS

Write for your copy of the Gothard Catalog

You will want a copy of this new Catalog which illustrates and describes the complete line of Standard Model Gothard Pilot Light Assemblies, giving dimensional diagrams and prices. If you have a special Pilot Light requirement—ask Gothard Engineers for a solution.

Gothard

MANUFACTURING COMPANY • 1310 North Ninth Street • Springfield, Ill.

Solve Voltage Variation PROBLEMS IN AIRCRAFT, TANKS, ETC. WITH

AMPERITE

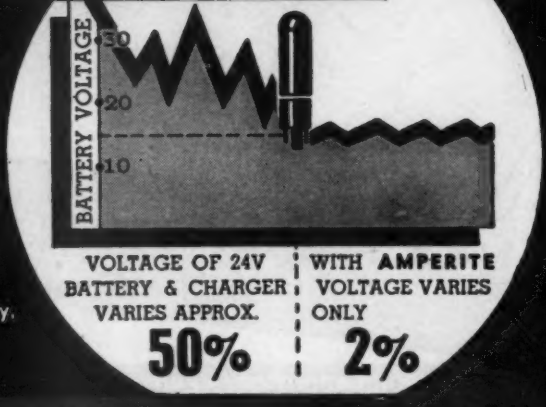
BATTERY CURRENT & VOLTAGE REGULATORS

Features:—

1. Amperites cut battery voltage fluctuation from approx. 50% to 2%.
2. Hermetically sealed — not affected by altitude, ambient temperature, or humidity.
3. Compact, light, and inexpensive.

Now used by U. S. Army, Navy, and Air Corps.

Send us your problem.



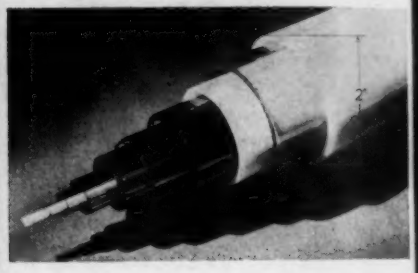
icals for boiler feed water treatment, etc. It has a self-starting synchronous motor which drives a cam operated switch mechanism through the medium of an enclosed gear train. The percentage of operating time is a function of the motor driven cam in relation to a similar stationary cam fixed to a calibrated dial. Varying the position of the stationary cam alters the relation between the contact mechanism and opens and closes it a defintie percentage of the total cycle as indicated on the dial.

The timer is available in different time ranges, ranging from 30 seconds to 60 minutes total cycle. The single pole, single throw contact is rated at 10 amp at 115 volt or 5 amp. The entire timer is enclosed in a dust tight case for flush mounting. It also can be furnished with various types of surface mounting steel connection boxes.

R. W. Cramer Co., Inc., Centerbrook, Conn.

Seamless Plastic Tubing

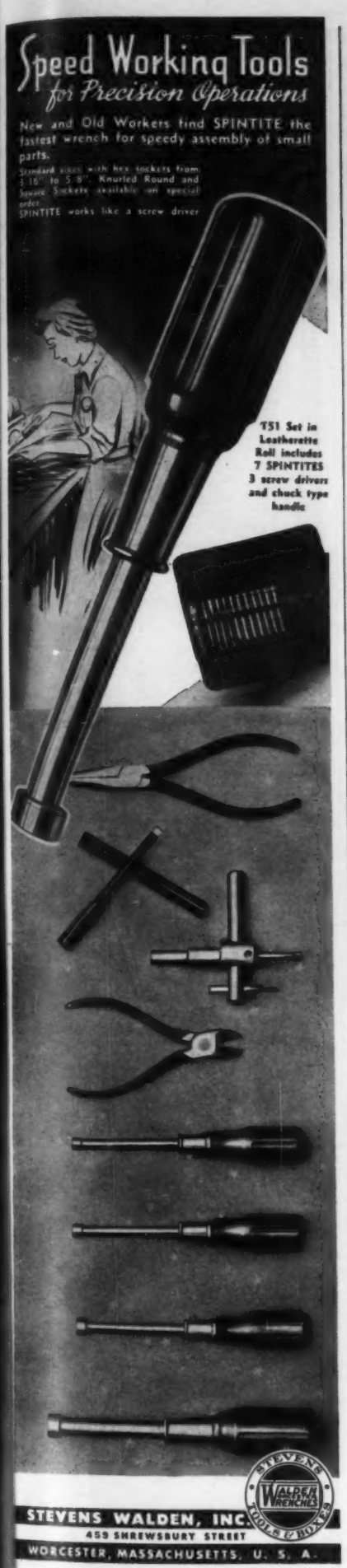
"TULOX" TT SEAMLESS plastic tubing is now available in all diameters up to 2½ ins. O.D. Extruded from Tennessee Eastman cellulose acetate butyrate, this tubing is available

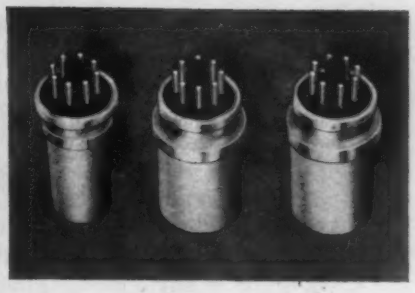


from warehouse stocks throughout the country through Crane Company, Chicago, Ill., and Julius Blum & Company, Inc., New York City. The tubing is manufactured by Extruded Plastics, Inc., Norwalk, Conn.

Improved Electrolytic Condensers

THE PLUG-IN dry electrolytic condensers which are illustrated are for use in the elimination of low frequency ripple (2—100 cps). They are small, lightweight, easy to mount or remove, and are designed to perform efficiently under adverse temperature and climatic conditions. The


Speed Working Tools
for Precision Operations
New and Old Workers find SPINTITE the fastest wrench for speedy assembly of small parts.
Standard sizes with hex sockets from 3/16" to 5/8". Knurled Round and Square Sockets available on special order.
SPINTITE works like a screw driver
T51 Set in Leatherette Roll includes 7 SPINTITES 3 screw drivers and chuck type handle
STEVENS WALDEN, INC.
459 SHREWSBURY STREET
WORCESTER, MASSACHUSETTS, U. S. A.

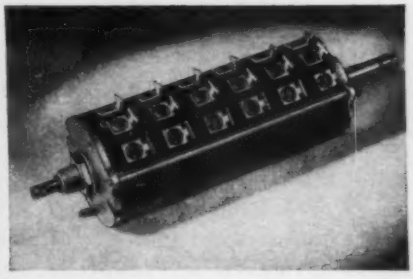


condensers can be sealed, or they may be soldered or welded into the unit.

Sprague Specialties Co., North Adams, Mass.

Tandem Controls

NO. 42 SERIES Control was developed to meet radio and electronic requirements where simultaneous control of several circuits is necessary. A plurality of circuits (up to twenty-four) can be controlled by the single shaft of this unit. Case design permits nesting and locking of all units into a compact stack. Metal end discs and tie rods hold the cases together and provide further rigidity. The single shaft passes through and



locks with each rotor in the stack. Thus the finished assembly is really a single control with several independent sections for as many independent circuits. All units pass through the same degree of rotation as the single shaft is rotated. Individual units can be of any standard resistance, taper, taps and hop-offs to meet individaul circuit requirements.

Clarostat Mfg. Co., Inc., 285 North 6th Street, Brooklyn, N. Y.

Split-core Current Transformer

THIS TRANSFORMER supplements, but does not replace, the manufacturer's "Universal" closed-core transformer. When used on 60 cps with an a-c

PAMPERED DARLINGS

Don't look so sad, pooch. Before this war upset everything, many an ABBOTT was a "pampered darling" too . . . cozily nestled in a protected radio shack . . .

Now, ABBOTT transmitters and receivers are subjected to many front line rigors and inconveniences. But they are tough little units, none the worse for being kicked around.

This is an ABBOTT TR-4, one of our standard models — a compact and efficient ultra high frequency transmitter and receiver. It is only an indication of the *type* of apparatus that we can and do produce. Our facilities may be of assistance, if you have a problem within the scope of our activities.

ABBOTT INSTRUMENT, INC.
8 WEST 18 STREET • NEW YORK, N. Y

Humor YOUR MICROPHONE

You'll Get More Out of It!

Like a bottle of Seltzer water, a mike deteriorates once it's been opened!

How TURNER Microphones Can Live to an Active Old Age . . .

Turner Microphones are precision engineered to give you long and faithful service. However, all Microphones are delicate and sensitive instruments, and will serve longer and better when treated with respect.

DO: Use good judgment in handling your mike. Read the instructions and follow them. If it gives trouble, send it to the factory or its dealer for repair.

DON'T: Open the microphone case. To do so exposes the sensitive parts to mechanical and chemical damages which can and will ruin the microphone.

Write today for your free copy of the new Turner Microphone Catalog.

The TURNER CO.
Cedar Rapids, Iowa, U.S.A.

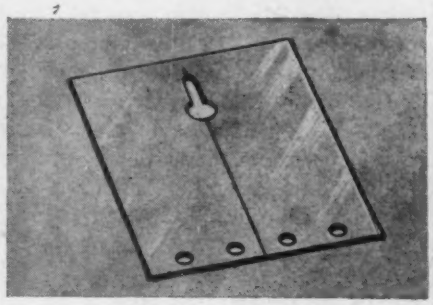
ammeter imposing a burden of 10-volt-amps, the readings are correct within 1 percent on the 600-amp range, within 1 percent on the 300-amp range, and within 2 percent on the 150-amp range. When used with a graphic wattmeter, the readings of the instrument are affected both by ratio and phase angle errors, but the effect of phase angle is negligible when the power factor is near 100 percent. As the power factor departs from unity, the error due to phase angle increases rapidly. The phase angle error of the 600-amp range is small, on the 300-amp range it is moderate, and on the 150-amp range is still higher.

Two distinct features claimed for the instrument are that it is designed for a ten volt-amp burden which approximates that imposed by most graphic meters; and that by interleaving the lamination at the joints in the core, the phase angle errors are held very low.

Bulletin No. 842 describes the instrument thoroughly and contains graphs. It is available from The Esterline-Angus Co., Inc., Indianapolis, Ind.

Hairline Indicator

HAIRLINE INDICATORS (made to customer specifications) consist of a fine line engraved on a small sheet of Vinylite, plastic-inch filled. The indicator itself is a sheet of plastic 40/1000th of an inch thick which can be supplied in any size, thickness or width of line (widths may be as narrow as 1/1000 of an inch, or



heavier). The indicators maintain dimensional stability under all conditions of humidity and temperature.

Information as to how these indicators may be adapted to particular needs of optical engineers or others may be obtained from the manufacturer, Printloid, Inc., 93 Mercer St., New York, N. Y.

WINCO DYNAMOTORS
Are On The Job To Get Them
OVER THE SPOT

BERLIN
ROME
TOKIO

Winco Dynamotors are always ready to "dish it out" . . . whether in the numbing cold of the stratosphere or in the flaming desert heat. Right on the job—constant and reliable—they supply power that will keep your communications clear and intelligible.

Simple or complex, whatever your specifications, we believe Winco will meet them. Already our engineers have done marvels in lightening weight, increasing efficiency and eliminating hash. They are at your service for new or special designs. Simply write or wire us. No obligation, of course.

ONLY WINCO GIVES YOU
ALTI-TEMP
The Dynamotor specially designed to insure maximum efficiency at all operating altitudes and temperatures.

WINCO DYNAMOTORS

Literature

Coaxial Cable and Cable Accesories. In this 16-page bulletin, which is made up of a combination of several small bulletins, the performance, applications, dimensions, mechanical and electrical properties of coaxial cables are given. Sealed terminals for coaxial cable and attachments for sealed terminals, connectors for soft and hard cable, reducer connector, junction box, and other accessories for coaxial cable are described and illustrated. Gas equipment and dehydrated air equipment are explained. A new type of cable terminal, glass-to-metal seal, especially suited for high frequencies is described and illustrated together with gas fittings for glass seals. The principle of operation and the features of a direct reading phase monitor for use in directional arrays and remote indicating antenna ammeters are also included. Bulletin available from Victor J. Andrew Co. 363 E. 75th St., Chicago, Ill.

Photoelectric Relays and Magnet Wire. Bulletin GEA-1755E describes and illustrates photoelectric relays for automatic control. The general purpose relays illustrated are types CR7505-K2 relay, for indoor use on 110 v, CR7505-K105 relay, for indoor use on 115 v and CR7505-K108 outdoor relay.

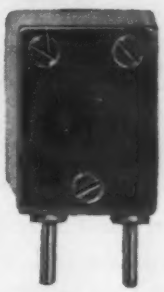
Bulletin GEA-3911 describes Formex magnet wire. In this 28-page catalog the history, properties of Formex, advantages, types available, application and data tables are covered.

Both Bulletin GEA-1755E and Bulletin GEA-3911 are available from General Electric, Schenectady, N. Y.

Electrical Contacts. Catalog No. 152 discusses the design, manufacture and application of electrical contacts of silver, platinum, tungsten, molybdenum and several other metals and alloys. The physical size and shape and the particular applications to which each metal and alloy is best suited are also presented. Bulletin No. 152 from Callite Tungsten Corp., Union City, N. J.

Some of Our "Secret" Weapons Will Be Available For Your Post-War Products

Naturally, many recent electronic improvements are military secrets. But there is nothing secret about the fact that many of today's war-time applications will revolutionize tomorrow's peace-time products. New Conceptions of tolerances, hardly dreamed of in pre-war products, provide unusually accurate, crystal-selected pick ups instantly. Your business future may depend upon the designing or redesigning such improvements into your post-war models. Although our present output goes into war-essential channels, our thinking is not subject to priority. Our application engineers will be happy to make recommendations involving the use of war-perfected crystal units for "future" products.



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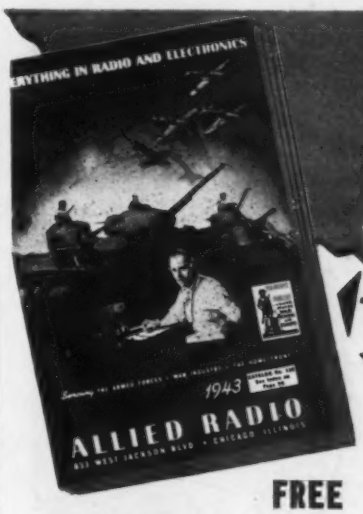

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Cut-off Wheels. Rimlocks are a new development in diamond cut-off wheels, made especially for quartz cutting. Rimlock blades are made in steel bond and copper bond. They may also be used for cutting glass, tile, ceramic and vitreous products, glazed face brick, porcelain and material of similar construction. Other operational ideas are given and a stock list is included. Felker Mfg. Co., Torrance, Calif.

Photocopy Machine. Apeco copying machine makes copies directly from blueprints, drawings, tracings, bills of material, special wiring or mechanical diagrams, field plans, specifications, useable new copies of old tracings and department orders. Copies can be made up to 18 x 22 inches, weighs ten pounds and operates on either a-c or d-c. Folder available from American Photocopy Equipment Co., 2849 N. Clark St., Dept. 157, Chicago, Ill.

Reference Manual. Design data on cathode-ray equipment and factors upon which final specifications rests are covered in this reference manual. Characteristics and descriptions of all DuMont cathode tubes, oscillographs plus application notes are included, also special equipment developed for particular laboratory and production testing projects. Copies available from Allen B. Du Mont Labs, Inc.; Main Ave., Passaic, N. J.

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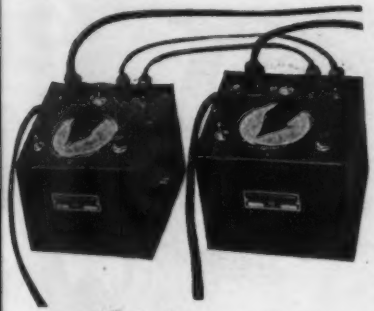

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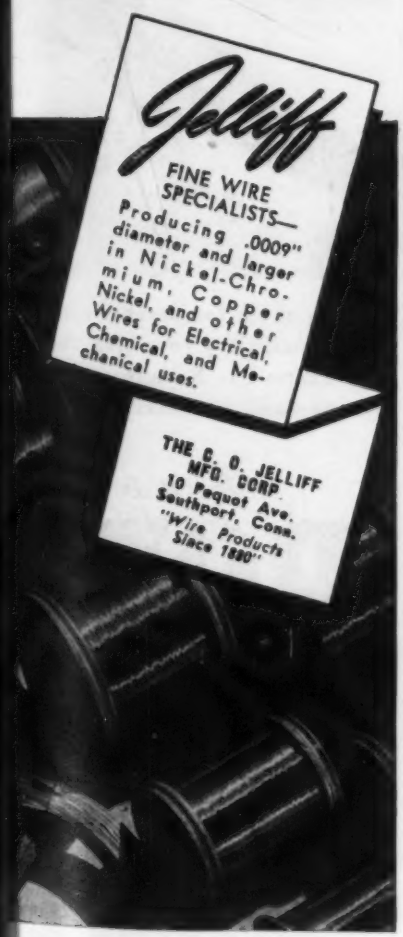
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Automatic Ballast-Regulating Tube. In a four page folder the regulating characteristics, curves and circuits for automatic ballast-regulating tubes are given. Amperite Co., 561 Broadway, New York, N. Y.

Shiftograph. A perpetual work shift schedule on a modified slide-rule basis showing executives how to operate equipment on various time schedules depending upon the number of crews, number of weekly hours and percent plant activity. Available to executives and plant managers from George S. May Co., Channin Bldg., New York. N. Y.

Automatic Control Units. Bulletin No. 140 describes and illustrates magnetic contactors, reversing controls, automatic reset timers, process timers, program clocks, remote control switches, and automatic transfer switches. The details of construction, latest improvements, applications and price lists are included. Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

Dynamotors. The *Carter Magmotor Memo* is a journal devoted to the operating, servicing and maintenance of dynamotors. This journal contains the latest dynamotor and generator developments, service kinks, timely articles and round table discussions. Available from Carter Motor Co., 1608 Milwaukee Ave., Chicago, Ill.

Electronic Equipment. "Electronic Index", Bulletin No. 170, contains information on new rectifiers, rpm controls, converters, inverters and cycle changers. Available from Electron Equipment Corp., Palm Springs, Calif.

Multi-contact Timers. Bulletin 3000 gives the applications, construction, standard features and motor style selection of type MC4-60M multi-contact timer. This model is a controller for sequential operation of solenoids, valves, motors, machine tools, signaling systems, laboratory tests, mixing equipment and heating and ventilating systems. Bulletin 3000 available from R. W. Cramer Co., Inc., Centerbrook, Conn.

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Tubes. "Tips on making Transmitting Tubes Last Longer" is the title of a booklet written as an aid to users of electronic tubes in the industrial and broadcast fields. Five general rules are listed; a chapter on how to double the life of tungsten filament tubes, another on how to make mercury-vapor tubes last longer, one on tube rest periods and one explaining why cooler tubes last longer. RCA, Victor Div., Camden, N. J.

RCA Tube Handbook All-Types HB-3 contains general information on receiving transmitting, and cathode-ray tubes, phototubes and miscellaneous tubes. Data for each type included in the handbook, is covered in the general section. Available on subscription basis. RCA Commercial Eng. Section, Harrison, N. J.

RCA phototubes for light operated relays, light measurements and sound reproduction are covered in this 16-page folder. The theory, construction and operation are explained. Circuits, curves and charts are included. RCA Commercial Eng. Section, Harrison, N. J.

"Radio and Electronics" is a booklet which describes the part played by radio and electronics in this war. The booklet points out how war speeds development, how electrons are produced, how radio tubes perform, and the outstanding results of research. Radio Corporation of America, 30 Rockefeller Plaza, New York, N. Y.

Revised edition of the RCA Guide for Transmitting Tubes, designed especially for radio engineers and technicians in the armed service and war industries. Commercial Engineering Section, RCA, Harrison, N. J.

RCA Tube Picture Book enables visual instruction in the constructional details of various types of vacuum tubes. The book consists of 16 pages; there are 8 charts which can be used for display mounting. Commercial Engineering Section, Harrison, N. J., ten cents each.

House Organ. In the February-March issue of *Wheelco Comments* there is an article "Prolong Instrument Life" which is a convenient guide on instrument care. Available from Wheelco Instruments Co., Harrison and Peoria St., Chicago, Ill.

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Colloidal Graphite. A 4-page illustrated bulletin No. 422-EE illustrates and describes the use of "dag" colloidal graphite as a parting compound. The uses of colloidal graphite are pointed out and its application to aviation and deep sea diving equipment.

Bulletin No. 430-EE describes "dag" colloidal graphite, and its importance to modern industry, and its physical and chemical properties.

Bulletin No. 421 contains information on assembling and running-in engines and machinery. All three bulletins available from Acheson Colloids Corp., Port Huron, Mich.

Corrosion Work Sheet. This work sheet acts as a check list for all factors influencing corrosive action. It permits comparison of a problem with similar ones which may be used as a guide for selecting materials possessing satisfactory resistance. Copies of the Corrosion Data Work Sheet may be obtained from Technical Service, International Nickel Co., 67 Wall St., New York, N. Y.

Welding and Brazing Aluminum. Instructions for welding processes are given in this booklet. The important welding methods which are covered are: fusion welding, including the use of gas, metal arc, automatic and manual carbon arc and atomic hydrogens electric resistance welding, including spot, seam and butt-flash welding methods. Three brazing processes are described; furnace brazing, torch brazing and dip brazing. Booklet available from Aluminum Company of America, Pittsburgh, Pa.

Processing and Testing Machines. Catalog No. 431 contains information on "Kold-Hold" thermal, sub-zero and stratosphere processing and testing machines. The catalog is broken up into two sections. The first section covers processes employed in industry and the ranges of temperatures and pressures encountered. The second section covers the machines manufactured by this company for providing these temperature and pressure ranges. Aluminum rivet storage, aluminum sheet and parts storage, aircraft and other instrument testing, laboratory work, ma-

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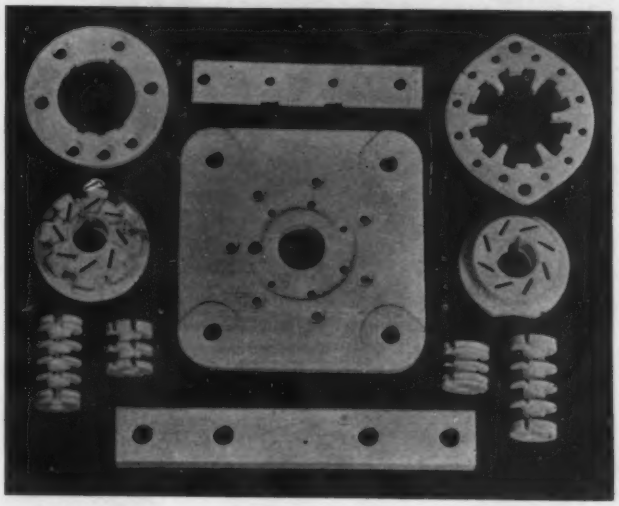

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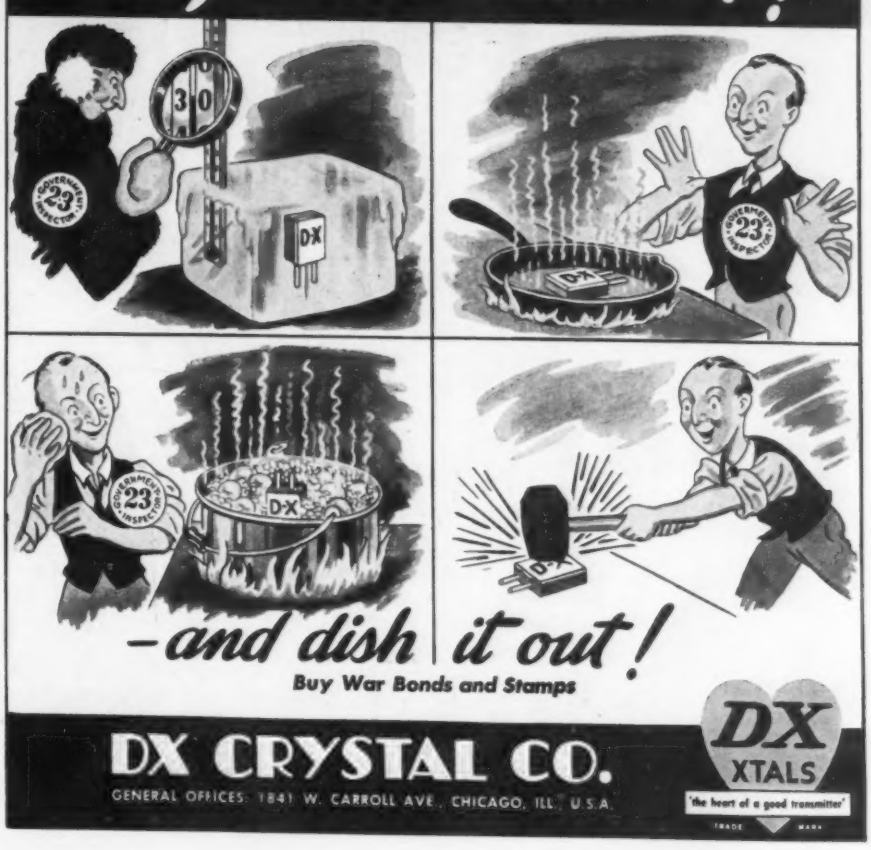

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terial testing, expansion fits, optical lens processing and stabilization of metals are the processes covered in the first section. Vertical, horizontal and side opening sub-zero machines, "Hi-Low" machines, sheet and rivet storage machines, dual-temperature baths, walk-in chambers, crystal test units and coolant coolers are the machines covered in the second section. The machines are illustrated and their capacities and dimensional drawings are given. A listing of instruments and accessory parts are also included. Also available are folders on individual machines such as crystal test units. All available from Kold-Hold Mfg. Co., Lansing, Mich.

Test Equipment. Catalog E-53-441(1) describes the type U test set. This is a portable Wheatstone bridge for measuring resistance and capacitance. It may be used to locate faults on telephone and telegraph cables, faulty wire in a cable, for measuring conductor resistance, locating grounds and crosses by Varley and Hilborn loop tests and locating opens by capacitance tests.

Catalog E-53-400(1) describes type S test set. This is a general purpose portable Wheatstone bridge with galvanometer and battery. It may be used for ordinary measurements of resistances in laboratory, shop, field, outside plant construction and maintenance forces in measuring conductor resistance and in locating grounds and crosses in a cable by Murray and Varley loop methods.

Both catalog E-53-441(1) and Catalog E-53-400(1) available from Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.

Reproduction Paper and Cloth. Photact reproduction papers and cloths are described in an eight page illustrated booklet. This booklet tells how to preserve, restore and duplicate original drawings by this new preservation method in which the photact print becomes the original from which blueprints and other reproductions can be made. Photact Dept., Keuffel & Esser Co., Third & Adams St., Hoboken, N. J.

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★Modulation "ON-OFF" Switch.

★No calibration or tuning charts required.

★Size 5" x 8" x 8½". Weight 12 lbs.

Operates on 115, 130, 150, 220 and 250 volt 25 to 60 cycle A.C. Supplied complete with Bliley 100 and 1000 K.C. duofrequency crystal and one 6V6 oscillator, one 6N7 harmonic generator, one 6L7 harmonic amplifier and one 6X5 rectifier.

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Brazing Alloys. Bulletin No. 12-A is a revised edition of a previous catalog on Sil-Fos and Easy-Flo brazing alloys. The application, uses and advantages of low temperature silver alloy brazing are given in this 18-page bulletin. Army, Navy, Federal and other specifications are given.

In the recent issue of *Low Temperature Brazing News*, No. 22, instances are shown where brazing alloys have simplified and speeded up war production. Bulletins are available from Handy & Harman, 82 Fulton St., New York, N. Y.

Glass Working Equipment. Catalog No. 43-B describes all types of gas, air and oxygen burners, economizers, gas and air mixers and glass rollers. The catalog is very thorough and contains over 750 illustrations. Available from Eisler Engineering Co., 750 South 13th St., Newark, N. J.

Radio Wire. Catalog 843 briefly describes and illustrates aerial wire, lead-in wire, transmission line cables, soldering irons, cords, terminals, microphone cable, PA and communicating system cables, multiple conductor cable, auto-radio wire and hook-up wire. Copies available from Belden Mfg. Co., Chicago, Ill.

Capacitors and Design Data. In the August 1942 issue of *The Aerovox Research Worker* contains an article "Capacitors in Control Circuits." This article deals with requirements for control capacitors in motor acceleration and special purpose circuits.

In the September-October issue of *The Aerovox Research Worker* Part I of "Design Data for *m*-Derived Type Filters" is presented. This is the first of a series to be presented. They will cover the design of *m*-type filters for low-pass, high-pass, band-pass and band-suppression applications. Available from Aerovox Corp., New Bedford, Mass.

Hard Facing. Bulletin No. 153 describes "No-Wear", a cemented carbide for hard facing. The methods of application, typical uses, advantages and physical characteristics are described and illustrated. Callite Tungsten Corp., Union City, N. J.

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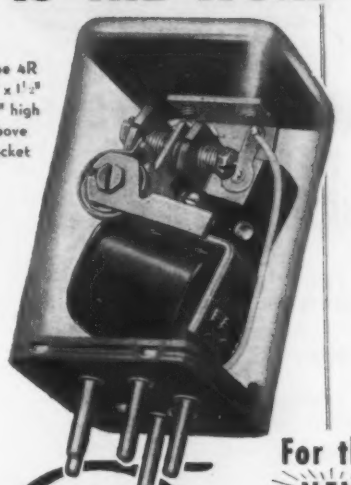

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Electrical Parts. Bulletin 101 contains data on relays, solenoids, switches and miscellaneous electrical parts required to meet Army-Navy specifications. Available from R-B-M Manufacturing Co., Div. of Essex Wire Corp., Fort Wayne, Ind.

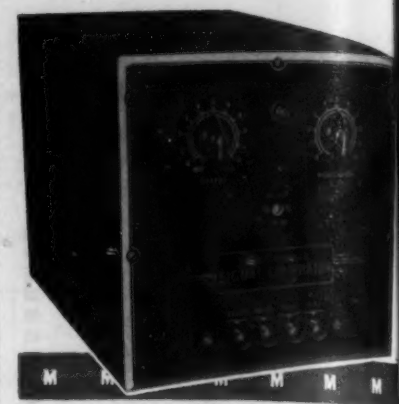
Electronic Contacts. Bulletin GEA-3058B describes ignitron contactors for fast, accurate power switching of a-c resistance welding machines. The features are given along with description and illustrations of their construction. Bulletin GEA-3058B from News Bureau, General Electric Co., Schenectady, N. Y.

Calculator. In the March issue of *Ohmite News* there is a description of the Ohmite Ohm's Law Calculator. The calculator is 41/8 x 9 inches, requires only one setting to obtain the answer to Ohm's Law problems, values are direct reading over the entire range. There are scales on both faces; one covers resistance from 0.1 ohm to 1,000 ohms and the other side extends the range up to 10 megohms (10,000,000 ohms). Currents in the commercial range are given in amperes and the radio-electronic range are in milliamperes. Calculator available from Ohmite Mfg. Co., 4835-41 Flournoy St., Chicago, Ill., for ten cents.

Broadside. In this broadside, a 14 x 20 inch reference wall chart which covers "Expansion Bolt and Screw Anchor Dimensional Chart" is described and explained in detail. Available from The Rawplug Co., Inc., 98 Lafayette St., New York, N. Y.

Plastics. Styraloy 22, a new plastic, is suitable for electrical applications where both low and high temperatures are needed. The general characteristics, physical form and types supplied, mechanical properties, electrical properties and applications are given in this 14-page booklet. Available from The Dow Chemical Co., Midland, Mich.

A folder which illustrates the possibilities of plastic parts in war production applications has just been issued by Creative Plastics Corp., Technical Sales Dept., Kent Ave., Brooklyn, N. Y.



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Electronic Instruments. Bulletin No. 127 describes model 703 signal generator, model 419 master multitester, models 416 and 418 pocket multitesters and model 446 a-c, d-c multitester. Bulletin No. 127 from Radio City Products Co., Inc., 127 W. 26th St., New York, N. Y.

Fixtures and Accessories. Engineering Bulletin No. 201 describes new fixtures and accessories for use in conjunction with the Philips Metalix X-ray Quartz analysis apparatus. Fixtures described and illustrated in this bulletin are goniometers and fixtures for x-ray measurement of quartz angles, crystal blank holders, rotating wafer and rotating crystal blank holders, edge correction holder, angle correction holder and Bragg angle scale. A bulletin which describes this equipment is available from Philips Metalix Corp., 419 Fourth Ave., New York, N. Y.

Spark Plug Bushing. Bulletin No. 37 gives the advantages and applications of "Heli-Coil" spark plug bushings. This is a hard, smooth stainless steel wire insert, used with the threaded spark plug. It comes in 18 mm and 14 mm sizes. Bulletin available from Aircraft Screw Products Co., Inc., 47-23 35th St., Long Island City, N. Y.

Alloy Die Castings. The outstanding features and methods of producing zinc alloy die castings are presented in a booklet entitled "Zinc Alloy Die Casting". The booklet is written up in question-and-answer style. Copies available from The New Jersey Zinc Co., 160 Front St., New York, N. Y.

House Organ. The new American War Standard covering Ceramic Materials for Radio Insulators, Class L is available from the below address at twenty-cents per each copy.

The new war standard, "Power and Audio Transformers and Reactors, Home Receiver Replacement Type", has also been issued by the American Standards Association, 70 W. 39th St., New York, N. Y. It covers performance and quality requirements for a simplified list of 24 units which will be sufficient to service about 90 percent of all radio sets.

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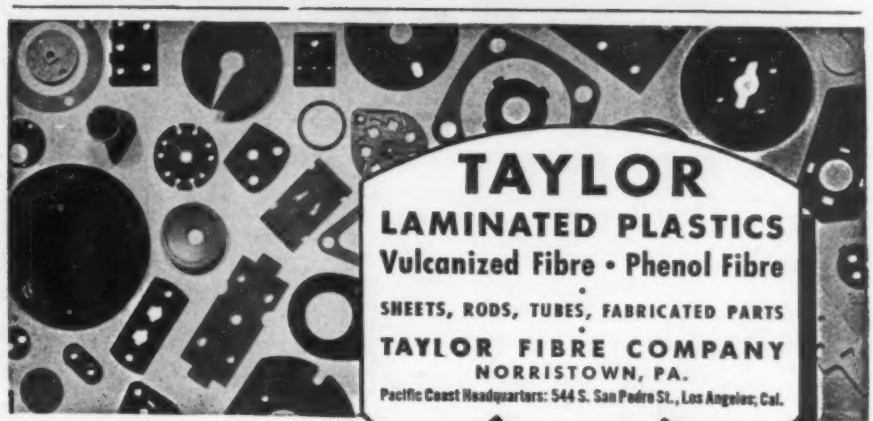

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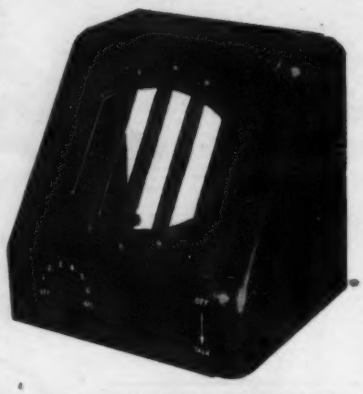

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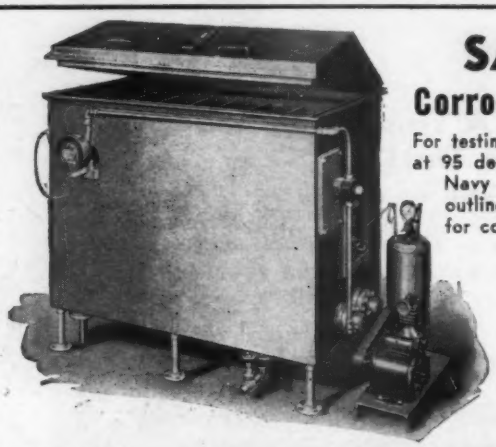

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The use of British technical terminology and illustrations of British products indicate that the book was originally written and published in England, though no direct statement to this effect could be found.—J.M.

• • •

Alternating-Current Machine

BY A. F. PUCHSTEIN AND T. C. LLOY
John Wiley & Sons, Inc. 655 pages Price, $5.50. Second Edition—19

SINCE THE APPEARANCE six years ago of this fourth-year engineering college textbook devoted exclusively to alternating-current machines, considerable progress has been made within the industry on standardization of methods of analysis, rating and characteristics. Complete sections of the book have therefore been rewritten by the authors to make this second edition conform with current practice. Standardization data has been inserted in many other sections, and certain sections have undergone revision as a result of suggestions made by practicing engineers and educators who have used the book during the past six years.

In general, the scope and character of the book have not been changed in the revision. The material is within the scope of fourth-year college students, and is so arranged that any desired fracti

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of the material can be covered in the classroom. The authors point out that students become intimately acquainted with the entire book as a source for future reference even though limitations on available time make it necessary to restrict study to selected sections.

Concise descriptions of actual machines and parts add to the interest of the book; in fact, the scope of the material in most sections ranges from brief descriptions of construction features to theoretical formulas on which initial design calculations are based.

Although formulas appear frequently, the derivations of these formulas are usually omitted in the interests of simplicity. Likewise, the details of setting up equivalent electrical circuits are justifiably left out.

The seven-page section covering theory, construction and applications of mercury-vapor rectifiers deserves special mention for its conciseness and clarity.

All diagrams are clear and well-prepared, though of necessity graphs and vector diagrams predominate. Problems are grouped by chapters at the end of the book, with answers being given immediately after some of the problems.—J.M.

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The Inductance Authority

By EDWARD M. SHIEPE, *Gold Shield Products, New York, 50 pages. Price, $2.50.*

THE PURPOSE of this volume is to facilitate construction of air-core solenoid inductances for tuned circuits between audio frequencies and ultrahigh frequencies by dispensing with numerical calculations. By means of thirty-six of the thirty-eight charts which are presented, the inductance of coils whose diameter may be between $\frac{3}{4}$ in. and 3 inches, and which may be wound with No. 14 to No. 32 wire, can be determined by reading off the inductance from the proper line on the appropriate chart. Ten pages of text explain the use of the charts and discuss the general problem of the design of solenoid inductances.

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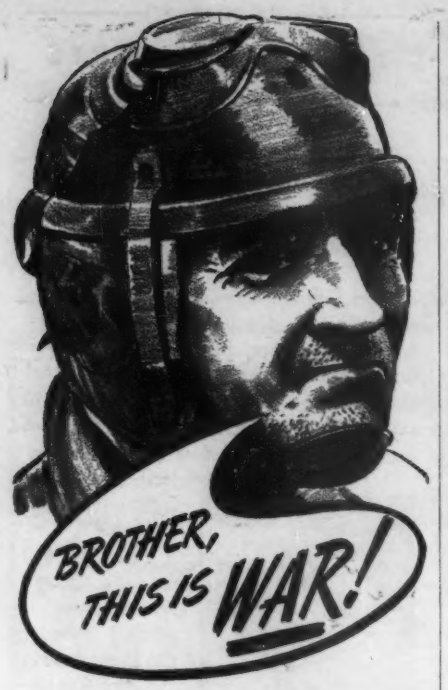

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The Electron Microscope

By E. F. BURTON AND W. H. KOHL, *Reinhold Pub. Co., New York City, 1942, 233 pages. Price $3.85.*

THE SMALLEST PARTICLE which man can see with even the finest optical microscope is limited by the wavelength of visible light to a linear dimension of at least 1/250,000th of an inch. The use of ultraviolet light and photography permits pictures of particles about half this size, and this is the optical limit which has constituted an impasse for the microscopist since about 1900. The development of the electron microscope broke this impasse, and hundreds of scientists with unsolved problems of microscopy are now seeing clearly objects which previously had been completely invisible or only dimly perceptible.

A complete and successful electron microscope was built in 1938 at the University of Toronto under the supervision of the authors of this book, Dr. Burton being head of the department of physics and Dr. Kohl having been associated with him at that time. The construction work was done by two post-graduate students, James Hillier and A. Prebus, with James Hillier now being in charge of electron microscope development at RCA Laboratories in Camden.

To present a detailed yet almost entirely nonmathematical explanation of how an electron microscope works, the authors start with the human eye, explain how it functions, then use it as a guidepost for explaining the optical principles of ordinary microscopes. Step by step they demonstrate why a limit of magnification is reached with an optical microscope, using simple diagrams and analogies. Following chapters deal with the nature of light and with elementary electron theory. All in all, the first nine chapters appear intended to provide a background of physics for the nontechnical reader, and can well be skimmed or skipped by the engineer.

The basic theory of the electron microscope starts in the tenth chapter, which deals with the movements of electrons in uniform and nonuniform fields. Following chapters logically cover electron and magnetic lenses. After a brief historical interlude, the electrostatic electron microscope is taken up in detail, with considerable data on results obtained with different cathode films in t electron gun. Finally, the comme cial form of electron microscop using magnetic lenses correspon ing to those in an optical compou microscope, is explained.

The final chapter treats of the a complishments of the electron micr scope only sketchily because, in t words of the authors, "this book not to be a technical text but rath an introduction to the subject electron microscopy."

Illustrations include about 70 ele tron microscope pictures of botan cal, biological and mineral specimen but most of them are scatter through the book without regard f their relation to the text. Contin ity of text is further interrupted b the use of full pages for captio alone.—J.M.

• • •

Communication Circuits

By LAWRENCE A. WARE, *Associat Professor of Electrical Engineerin State University of Iowa, and* HENR R. REED, *Professor of Electrical E gineering, State University of Iow John Wiley and Sons, Inc., Ne York. 287 pages. Price $3.50.*

THIS BOOK, while intended primaril as first-course material for student of Communication Engineering, con tains chapters on the newer ultra high frequency techniques, particu larly with reference to transmissio lines and wave guides.

The first few chapters are devote to the derivations of the importan network theorems, together wit simple examples illustrating thei use in circuit analysis. There the follows a carefully developed outlin of the theory of the infinite trans mission line and the general trans mission line. Special applications such as the Ferranti effect and th method of locating impedance ir regularities, are described, and a short chapter treats the overall effi ciency of the line considered as a power transfer device.

Two sections on filters give the basic theory of constant K and m-derived filters. The presentation is confined to ideal filters (without dissipation) and examples are worked out for several of the usual types. An excellent treatment of impedance transformation includes material on the reactive L- and T-sections, and the quarter-wavelength line as an impedance transformer. The gen-

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By JAMES STOKLEY, *Ives Washbur New York City. 299 pages plus 28 i serted pages of illustrations. Pr $3.50.*

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Microwave Transmission

By J. C. SLATER, *McGraw-Hill Book Co., New York, N. Y. 309 pages, price $3.50.*

THE PERIODICAL LITERATURE of microwave transmission has become quite extensive during the past few years and without considerable effort it is difficult for the investigator, particularly one new to the field, to separate the significant material from the less important detail. With the intensive effort now going on in microwaves, Professor Slater's authoritative book, which summarizes and correlates existing knowledge on this new subject, will be of considerable usefulness to a busy physicist, engineer or student.

Professor Slater's treatment is of intermediate difficulty. He assumes, on the reader's part, a knowledge of vector analysis and of the fundamentals of electromagnetic theory. The mathematics he employs is not difficult however and a larger than usual amount of explanatory text makes the treatment unusually clear. That the book is intended for the practical man, rather than the theoretician, is testified by the use of the imaginary prefix j of the engineer instead of the theoretician's i. Furthermore, Dr. Slater employs the rationalized m.k.s. system of units, which, too is preferred by engineers, although now by many physicists as well.

The subject matter treated includes: transmission lines (both the standard telephone circuit theory and the theory based on Maxwell's equations are presented); a brief summary of pertinent electromagnetic theory; wave guides; radiation from antennas; directional antennas; transmission line and wave guide couplings.

The presentation of transmission line theory is the only textbook study of this subject from the radio point of view of which the writer is aware. Transmission line theory is not quite the same for the telephone and for the radio engineer. For one thing the magnitudes involved are different; and for another, so far as the radio engineer is concerned, standard transmission line theory is an approximation of electromagnetic theory, which is often, but not always, sufficiently exact. In earlier textbooks the treatments were directed at power and telephonic applications. Since Slater's presentation is from the high frequency point of view, this part of his book will be of value to all radio technicians, even those not directly interested in microwaves.

The chapters on antennas cover the patterns and radiation impedances of simple antennas, and of greater interest, a discussion of the directional antennas commonly used in microwave work. Included is an excellent non-mathematical discussion of parabolic reflectors, of which, to the writer's knowledge, the equivalent is not found elsewhere in the radio literature.

A subject which might have added to the usefulness of this book would have been a treatment of microwave propagation over the earth's surface. For reference use, too, the book might be more useful, if some of the sections had been made shorter, or if they had been divided into subsections.—D.P.

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Radio Data Chart

By R. T. BEATTY, *Published by Electronic Laboratories, Inc., Indianapolis, 86 pages. Price $1.75.*

THE SERIES OF ABACS included in this volume originally appeared some years ago in *The Wireless World* and, with some modification, an earlier edition has been available in book form for a number of years. The present arrangement of abacs have been brought up to date by the deletion of obsolete material, the inclusion of some additional charts not previously available in bound volumes, and by the extension of former charts to take into account the additional ranges of frequency, resistance, impedance, and other factors which have become of practical importance in recent years.

All of Mr. Beatty's charts are in the form of nomographs in which the engineering solution to a specific